COMPARE STUDENTS' ATTITUDES TO LEARN MATHEMATICS AND STATISTICS IN CHINA AND AUSTRALIA

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This research seeks to explore the attitudes of Chinese and Australian senior secondary school students' towards mathematics and statistics. An investigation is carried out to determine the relationships between these attitudes and certain factors. A preliminary analysis of the curriculum in China and Australia revealed that the subject in common in Year 12 is the study of statistics. Therefore, students' attitudes towards the study of statistics will receive particular attention here. This research project outlines the social environment, the family environment and the individual status of Chinese and Australian students. A comparative study, an empiricist' approach, an interpretive approach and a statistical analysis methodology were used to analyze the data. However, other conclusions of this study, such as sex not having an effect upon students' attitudes towards learning mathematics and statistics, has not been previously concluded.

PREPARATION OF RESEARCH STUDY

The research topic is slightly different to the investigations of previous researchers; we will address the attitudes of Chinese and Australian students' towards statistics based upon the following three factors: (a) Culture: Culture has been identified as one of the factors that strongly influence mathematics learning and teaching. For example, in the Eastern teaching methodology, there are verbal, individual instructions and using physical objects as teaching materials, while the Western model consists of group instructions in classrooms and using materials from books, film, radio, games and television. (b) Sex: Another factor that was considered was the effect of the sex of the student in learning statistics. Fennema and Levi (1998) have explored how sex differences in mathematics were related to various levels of tasks and age groups. (c) Parents: The family background of a student is an important factor to a child's development and achievement. Parental expectations and educational beliefs have strong effects on their children's performance and attitudes. Studies comparing overseas Chinese students and native students in western countries identified similar parental effects, although enculturation in the USA seemed to have diminished the cultural effects slightly. For example, Cao, Forgasz and Bishop (2005) explored parental influences on mathematics learning in China and Australia.

RESESARCH METHOD USED IN COMPARING STUDENTS' ATTITUDES

Fitted model and significant testing for difference in students' attitudes: When the response is ordinal (e.g., strongly agree, agree, neutral, disagree, and strongly disagree), a transformation to an interval scale is used. One model is the *proportional odds model*. Let π_{ijk} denote the probability that the response is at level "j" when a student with sex "k" lives in country "i". The cumulative probabilities are denoted by $\pi_{ijk}{}^* = \pi_{i1k} + \pi_{i2k} + ... + \pi_{ijk}$ for all i =1, 2, j=1, …,c-1, and k=1,2.

The proportional odds model has the form: $$\log\left(\frac{\pi_{ijk}{}^*}{1-\pi_{ijk}{}^*}\right) = \alpha_j + \beta_i + \gamma_k \quad \text{------- (1)}$$

Where the attitude has "c" ordinal levels scaled from strongly positive to strongly negative, and i=1,2, …r, j=1,2, …,c-1, k=1,2, and (1) with a constraint $\gamma_2 = \beta_r = 0$. The model is simply a logit model when the response is binary (McCullagh and Nelder, 2002).

We are interested in country or sex influences on attitude. In the proportional odds model (1), parameter $\{\beta_i\}$ describes country effects given sex. We let i=1 for an Australian student and i=2 for a Chinese student; and let k=1 for a male and k=2 for a female. The model says that for each sex the odds of having attitude below any fixed level for a student in Australia are exp(β_1) times odds for a student in China. Similarly, for each country the odds of having attitude below any

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fixed level for a male student are exp (γ_1) times the odds for a female student. We refer the ordinal odds ratio exp (β_1) or exp (γ_1) to cumulative odds ratio, since the model is based on the cumulative probabilities.

Chi-square test to study students' attitudes to mathematics: We analyzed these data with the chi-square test as it can be used for analysing ordinal data. The strength of the relationship between two variables can be measured in different ways depending on whether data are ordinal or not. Contingency tables are used in problems where data ordinal and we wish to know if these categories are independent or if these are some relationships between them. In these data the family information (Q17 to Q26), students' statistics attitudes (Q31 to Q51) and students' studying distributions orregression (Q52 to Q61) are the variables of interest, with: country (two levels) and sex (two levels).

THE RESULTS OF STUDENTS' ATTITUDES TO STATISTICAL LEARNING

Although the survey contained 64 questions, my statistical analysis focuses, in particular, on the questions concerning students' attitudes towards statistics. For each statement, students responded using a 5-point Liker scale, indicating whether their feeling toward the statement was strongly agree, agree, neutral, disagree or strongly disagree. Since almost all Chinese students failed to register an extreme response, we collapsed the students' responses into 3 levels. The responses were classified into the high category if their responses indicated a positive attitude for each question, i.e., strongly agree or agree; students with a negative response were classified into the low category, i.e., disagree or strongly disagree; the remaining were placed in the middle category, i.e. neutral. The results are presented in the following Tables.

The effect of parental influence: The chi-square test can be used to look at whether there is a "significant" or "non-significant" association between the ordinal variables. In our study, the ordinal variables are parents' attitudes and students' attitudes. Parents' attitudes are based on Q4, Q6, and Q22 to Q27. Students' attitudes are based on Q31 to Q51. The results of these chi-square tests indicate that a parental attitude affects their children's attitudes towards statistics learning. Table 1 show that Q24 is more significant with respect to a student's attitude based on Q31 to Q51.

Table 1. The numbers of significant associations between student's attitudes and family

	Family statements							
Attitude statements	Q4	Q6	Q22	Q23	Q24	Q25	Q26	Q27
Q31 to Q51	5	4	5	3	11	8	6	7

The difference between boys and girls in the case of distributions: As part of this project, we considered the responses of students of each sex and tabulated the percentages in each category as follows: (i) Q52. 'I have enjoyed learning about distributions' (results in Table 2).

Strongly Agree (SA) ☐ Agree (A) ☐ Neutral (N) ☐ Disagree (D) ☐ Strongly Disagree (SD) ☐

Table 2. Students' rating of enjoyment of distributions (%)

Country	SEX	SA	A	N	D	SD
China	F	2.6	12.8	51.3	23	10.3
China	M	0	21.4	54.8	11.9	11.9
Australia	F	0	33.3	33.3	20.9	12.5
Australia	M	18.2	40.9	27.3	13.6	0

Australia students were found to have a greater enjoyment of learning distributions (55.6% more than Chinese students). From the survey, it can be deduced that Australian boys enjoy learning mathematics much more than Chinese boys, with 59.1% and 21.4% respectively who rated as 'agree' or 'strongly agree'. Australian girls (33.3%) were also found to enjoy their statistics learning more than their Chinese counterparts (15.4%). The difference in attitude between Australian and Chinese students in learning distributions maybe explained by analyzing questions 54, 56 and 57. For example, we consider question 56 (Q56).

(ii) Q56. 'My mind goes blank and I am unable to think clearly when doing regression analyses' (Results in Table 3). Although there was a greater percentage of Australian students compared to Chinese students who struggled with leaning regression, overall, there was a large number of students of both nationalities who found learning distributions difficult (Boys 50% Australia, 31%;

China; Girls 48% Australia, 30.8% China). The percentage of students who did not have difficulty with learning statistics was very similar in both countries (Boys 18.2% Australia, 19% China; Girls 12% Australia; 15.4% China).

Table 3. Students' difficulty in studying regression analysis (RA) (%)

Country	SEX	SA	A	N	D	SD
China	F	0	15.4	53.8	30.8	0
China	M	7.1	11.9	50	28.6	2.4
Australia	F	4	8	40	40	8
Australia	M	0	18.2	31.8	45.5	4.5

(iii) Q57. 'Regression analysis makes me feel uncomfortable and inpatient' (Results in Table 4).

Table 4. Students' rating their comfort level with studying RA (%)

Country	SEX	SA	A	N	D	SD
China	F	2.6	28.2	46.1	20.5	2.6
China	M	9.5	14.3	47.6	26.2	2.4
Australia	F	4.1	8.3	54.2	16.7	16.7
Australia	M	0	13.6	27.3	40.9	18.2

More Chinese students chose "strongly agree and agree" (Boys 23.8%, Girls 28.2%) compared to Australian students (Boys 13.6%, Girls 12.4%). Regression analysis appears to be more easily accepted by Australian students (Boys 59.1%, Girls 33.4%).

(iv) Q54. 'I think regression is useful in real life' (Results in Table 5). The students were asked to rate the usefulness of learning indices in its application in real life. The results show that only a few Chinese students have extreme views regarding the application of regression in real life with 9.5% of boys and 5.1% of girls rating the question as "strongly agree" or "strongly disagree". Question 54 indicated that some Australian students considered regression to be useful in real life (Boys 45.5%, Girls 29.1%), but that a lower percentage of Chinese students (Boys 31%, Girls 18%) considered it useful.

Table 5. Students' rating the application of regression in real life (%)

Country	SEX	SA	A	N	D	SD
China	F	0	18	64.1	12.8	5.1
China	M	2.4	28.6	54.8	7.1	7.1
Australia	F	4.1	25	33.4	25	12.5
Australia	M	13.6	31.9	27.3	13.6	13.6

Fitting a logist model for categorical data: There are no significant differences in the sexe when students are asked about their attitudes towards statistics. The P-value is greater then 0.05, (p-value=0.595 for question 31; p-value=0.215 for question 42). The information relating to students attitudes are given by question 31 through to question 50. We focused, in particular, upon the differences between sexes. The chi-square results for the questions were listed in Table 6.

Table 6. The significance of sex for questions 31 through to 50

Question	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40
Chi-square	6.22	7.56	4.59	7.36	9.43	11.24	14.36	4.31	8.14	5.16

Question	Q41	Q42	Q43	Q44	Q45	Q46	Q47	Q48	Q49	Q50
Chi-square	4.8	11.37	6.08	6.93	10.23	4.04	3.36	4.67	3.48	3.65

The chi-square value (with 8 degrees of freedom) at 0.05 significance levels is 15.51. All the chi-square values in Table 6 are less than 15.51 at 0.05 significance levels; therefore, there are only non-significant differences in the attitudes of students of different sexes.

Possible differences between the attitudes of Chinese and Australian students towards statistics

The original responses were categorized into 5 ordinal levels, from 1 (strongly agree) to 5 (strongly disagree). As almost all Chinese students failed to register an extreme level, we collapsed students' responses into 3 ordinal levels: 1 (agree), 2 (neutral), and 3 (disagree). First, a logist model including the interactions between country and sex was fitted. It was determined that the interactions were no significant for all questions. Table 7 and Table 8 show the estimation of parameters and standard errors. It also gives the p-value of the test H_0 : parameter =0.

From the results, we can conclude that culture has an effect on a student's attitude towards learning statistics. The cultures in China and Australia are vastly different and Table 7 and Table 8 indicate that there are significant country effects on some issues. For example, in question 31, the p-value is 0.005 (or chi-square = 8.3380), and in question 42, the p-value is <0.001, therefore we would reject H_0: at the 0.05 level. In question 52, the p-value is <0.0001, therefore there is a high correlation. Consequently, the attitudes of students learning statistics are influenced by the cultures of Australia and China. From the results, we can see that students in Australia tend to enjoy learning statistics more than Chinese students. The odds that an Australian student enjoys learning statistics is estimated to be exp (1.015) =2.76 times greater than a Chinese student. However, Australian students are more likely to give up on a statistical problem if it is considered too difficult. The likelihood that an Australian student will give up on a difficult problem is estimated to be exp (3.272) =26.36 times greater than a Chinese student.

CONCLUSION

Some variables have been shown to exert a stronger influence on a student's attitude and performance in statistics. For example, the results indicate that the Australian and Chinese cultures have a significant effect on a student's statistics learning. Year 10 Australian students tend to enjoy statistics more than Year 10 Chinese students, however it may be concluded that Australian students are more likely to give up on a difficult statistics problem. Students with negative attitudes towards statistics showed lower achievement levels than their classmates, despite often completing more out-of-school study in mathematics. Then, spending a greater amount of time studying does not necessarily correlate with a higher achievement in statistics.

Table 7. The results of a fitted model from the different questions

Question	$\hat{\beta}_1$	s. e.	p-value	$\hat{\gamma}_1$	s. e.	p-value
Q31	1.015*	0.361	0.005	0.172	0.324	0.595
Q35	0.343	0.369	0.353	0.497	0.343	0.148
Q39	-0.293	0.348	0.399	-0.121	0.321	0.706
Q41	-0.293	0.348	0.399	-0.121	0.321	0.706
Q42	3.272*	0.659	<0.001	-0.643	0.518	0.215
Q50	2.154*	0.515	<0.0001	-0.148	0.368	0.687
Q59	0.138	0.328	0.674	0.323	0.318	0.310

Table 8. Maximum likelihood estimates of fitted logist models

Question	$\hat{\beta}_1$	s.e.	p-value	$\hat{\gamma}_1$	s.e.	p-value
Q31	0.5075*	0.1758	0.0039	0.0862	0.1621	0.5948
Q35	0.1715	0.1790	0.3381	0.2482	0.1711	0.1468
Q39	-0.1464	0.1691	0.3865	-0.0606	0.1601	0.7050
Q41	-0.1264	0.1590	0.3461	-0.4040	0.3121	0.7321
Q42	1.6361*	0.3285	<0.001	-0.3213	0.2620	2.2199
Q50	1.7068*	0.2594	<0.0001	-0.0740	0.1831	0.6863
Q59	0.0692	0.1691	0.6823	0.1614	0.1594	0.3110

Note: *****The parameter is significant at the 5% level.

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