Title	Cross-Country Comparison of Students' Perceptions on Learning Science.
Author(s)	Ruth Chellappah, Toh Kok Aun, Boo Hong Kwen, and Khoo Tse Horng
Source	*Teaching and Learning, 22*(2), 31-40
Published by	Institute of Education (Singapore)

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Cross-Country Comparison of Students' Perceptions on Learning Science

Ruth Chellappah, Toh Kok Aun, Boo Hong Kwen, and Khoo Tse Horng

Introduction

In this paper, students' perceptions on how they could do well in science are compared across nations. Data from eight countries are compared, namely England, Switzerland, the United States, Singapore, Hong Kong, Israel, Germany and Japan. These countries were selected for this study as they were part of an original six-nation study with fairly similar curricula, learning environments and pupil achievement.

In this analysis, students' perceptions of the factors that enhanced their achievements in science will be probed deeper with respect to the amount of homework, personal learning like memorizing of texts and classroom activities, and the outcome of the findings may prompt further research.

Background

The Third International Mathematics and Science Study (TIMSS) is a study of student achievement, instructional practices, curricula and cultural contexts around the world. Data from TIMSS carried out in 1994/95 was initially released in 1996. More details were published in 1997/98. It was the largest, most comprehensive and most reliable comparison of Mathematics and Science education ever done internationally. Involving 50 countries, it compared Mathematics and Science knowledge of about half a million students in 30 different languages from 3 different levels in schools ie. at Primary 3 and 4 for Population 1, at Secondary 1 and 2 for Population 2 and at Pre-university levels.

Among other things, the study looked closely at four factors that affected performance in the classroom:

- Curriculum and learning environment
- Teachers' lives
- Teaching and Learning
- Students' lives

TIMSS investigated many different aspects of science teaching and learning. All countries participating in the study had student assessment tests containing multiple-choice and free-response items. Syllabi and content of the mathematics and science textbooks in the participating countries were examined for topic content and sequencing. Some of the mathematics lessons at the secondary two levels in Japan, Germany and the US were videotaped to examine what typically happens in the classroom. Observations were analysed and a database was created for subsequent comparative analysis. Researchers observed and conducted in-depth interviews with small samples of students, teachers and administrators. Topics of study included the implementation of national standards, methods of dealing with student ability differences, adolescents' attitudes toward school, and the daily lives and working environment of teachers.

Students were asked to fill out questionnaires about background factors related to their achievement, including their opinions about learning and achievement in mathematics and science. Teachers were asked to answer questions about lesson structure and context, as well as their beliefs about the teaching of mathematics and science. School administrators were asked to answer questions about the implemented curriculum, staffing levels, availability of resources, in-service education, and retention rates of pupils.

Initial data, released in 1996, examined students' lives to find out what motivated them, what support they received at school and at home, and the types of obstacles they faced. It aimed at measuring students' success in a global society, comparing students' perceptions internationally with a view to improving science and mathematics education.

Findings and discussion

Students were asked to rate (within a scale of 4: strongly agree, agree, disagree and strongly disagree) a statement such as "To do well in science you need lots of hard work studying at home". The outcomes are shown in Figure 1. The majority of students from the 8 participating countries agreed that to do well in science, doing homework and studying at home is important.

Homework and success in science

Young people actually spend much more of their waking hours outside the classroom. During normal school days, four-fifths of students in

most countries reported averaging about half to one hour outside of school each day studying or doing homework in science. If we refer to Figure 1, **98% of Singapore students** responded positively that they needed lots of hard work studying at home to do well in science. TIMSS reports state that higher achievements in science are associated with a moderate amount of homework (at least one hour) per day. Internationally there is a high degree of agreement among students on this point. Percentages of agreement were in the 80s and 90s percentiles for most countries sampled. So if we want our students to perform better in our classrooms, teachers need to assign more homework to give their students more practice, so that they can keep up academically and perform better in tests. The lower percentage of students in Switzerland (75.5%) who agreed that more homework helped them perform better in science seems to indicate that they might get enough practice during school hours.

Figure 1. To do well in science you need lots of hard work studying at home.

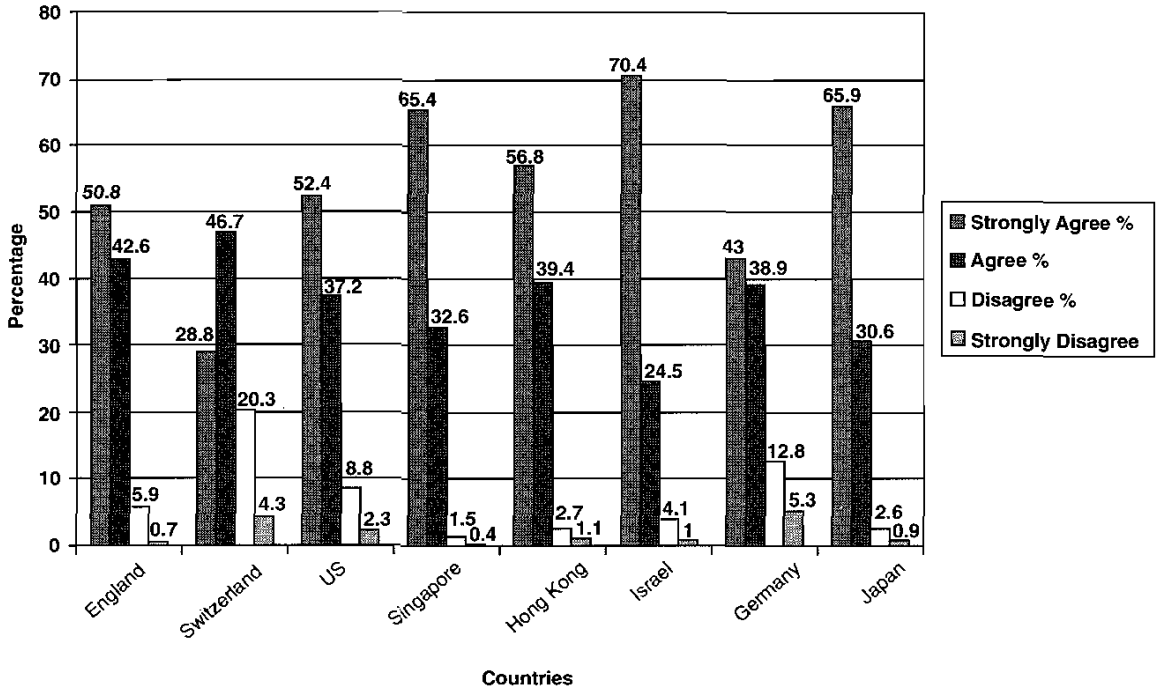

Table 1. Percentage of students agreeing and disagreeing with the statement, "To do well in science you need lots of hard work studying at home"

	England	Switzerland	US	Singapore	Hong Kong	Israel	Germany	Japan
Agree and Strongly Agree	93.4	75.5	89.6	98	96.2	94.9	81.9	96.5
Disagree and Strongly Disagree	6.6	24.6	11.1	1.9	3.8	5.1	8.1	3.5

Recent market research studies carried out on 1,742 students from 16 Primary schools in Singapore by Singapore Press Holdings in September 2000 support these findings from TIMSS 1995 (Straits Times, 2000). They found that six out of ten Singapore school children spend more than three hours a day studying at home and doing their homework; seven in ten receive tuition; and eight in ten take part in co-curricular activities after school hours.

Memorization of Textbooks or Notes

On the question of whether the students need to memorize their textbooks or notes, it is interesting to note that **a higher proportion of students from Asian countries** like Japan (97.5%), Singapore (86.9%), and Hong Kong (83.6%), indicated a need to memorize textbooks or notes (refer to Figure 2). Students from Western industrialized countries were almost equally divided in agreeing (50%–60%) or disagreeing (30%–40%) about the importance of memorizing textbooks or notes.

Could this be a reflection of the way they are taught and tested in the classroom? If questions asked in the classroom only test knowledge and recall of facts, children will only need to regurgitate what they have memorized. If teachers required their students to analyze and apply concepts learnt, students would need to think and sort information and thus not rely so much on memorized information. It could also be an indication of their confidence in the language of the classroom. To be able to explain science concepts in their own words, instead of having to memorize, would indicate good language abilities and understanding.

The Singapore Press Holdings market research study in September 2000 (Straits Times, 2000) notes that, seven in ten children in Singapore receive extra tuition after school hours, as parents want their children to improve their grades in their tests and examinations. This same survey quotes failing in tests and examinations as the most feared out of ten fears of Singapore children aged between 10 to 12 years. This would explain their great dependence on memorization from textbooks to make sure that they do get their answers right and so pass their tests well.

Figure 2. Need to memorize the textbook or notes.

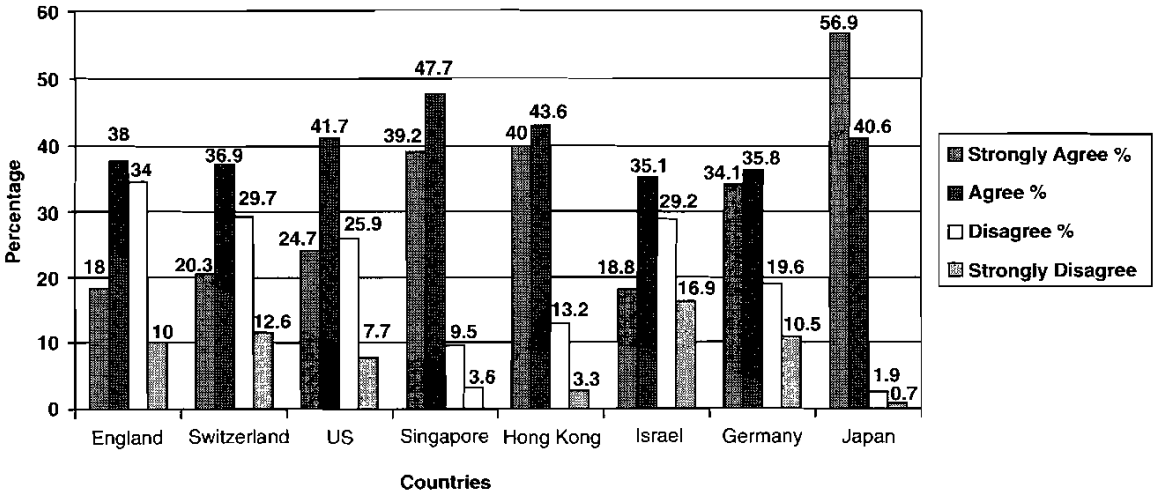

Table 2. Percentage of students agreeing and disagreeing with the need to memorize textbooks or notes.

	England	Switzerland	US	Singapore	Hong Kong	Israel	Germany	Japan
Agree and Strongly Agree	56.0	57.7	66.4	86.9	83.6	53.9	69.9	97.5
Disagree and Strongly Disagree	44.0	42.3	33.6	13.1	16.5	46.1	30.1	2.6

Teachers' role in facilitating problem solving

Figure 3. How often does the teacher show how to do science problems in your science lessons?

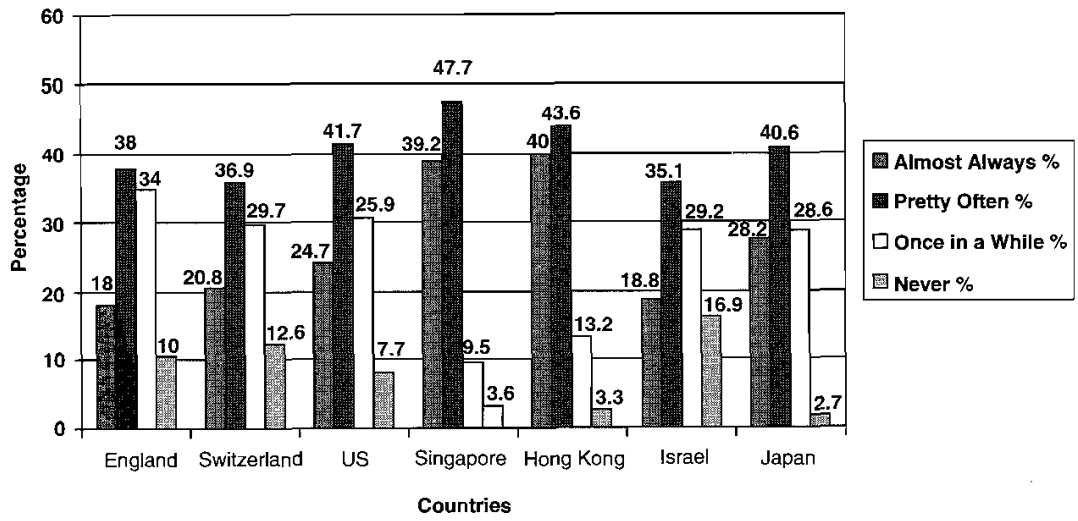

Table 3. Students' response on "How often does the teacher show how to do science problems in your science lessons?" (in percentages)

	England	Switzerland	US	Singapore	Hong Kong	Israel	Germany	Japan
Almost Always and Often	56	57.7	66.4	86.9	83.6	53.9	68.8	
Once in a While or Never	44.0	42.3	33.6	13.1	16.5	46.1	31.3	

In view of the recent emphasis on thinking skills, with the development of problem solving and creative skills in Singapore students, it is interesting to note that, in the 1995 data gathered from seven countries within the TIMSS study, **86.9% of the Singapore students** indicated that their teachers either almost always or pretty often showed them how to do their science problems in their science lessons. The parallel percentages for Hong Kong and Japan are 83.6% and 68.8% respectively. In general, teachers in Asian countries spend more time coaching their students in and out of their classrooms. This is supported by additional data from this study.

In England, the US, Switzerland and Israel, **a lower percentage of students**, ranging from 54%-66%, (Figure 3) indicated that their teachers either almost always or pretty often showed them how to do science problems in their science lessons. Is this a reflection of the more teacher-centred methods of teaching in Asian countries as compared to the more pupil-centred approach in Western countries? It is only in the past 3–5 years that Singapore schools have introduced creative thinking skills and practised more inquiry learning strategies in science classes. It is still not clear if there is a discrepancy between the intended curriculum which the policy makers and syllabi writers advocate, and the implemented curriculum which is what teachers actually teach in the science classes, even though the science curricula stresses inquiry approaches to teaching.

Frequency of project work in science

Figure 4. How often do you work on science projects in your science lesson?

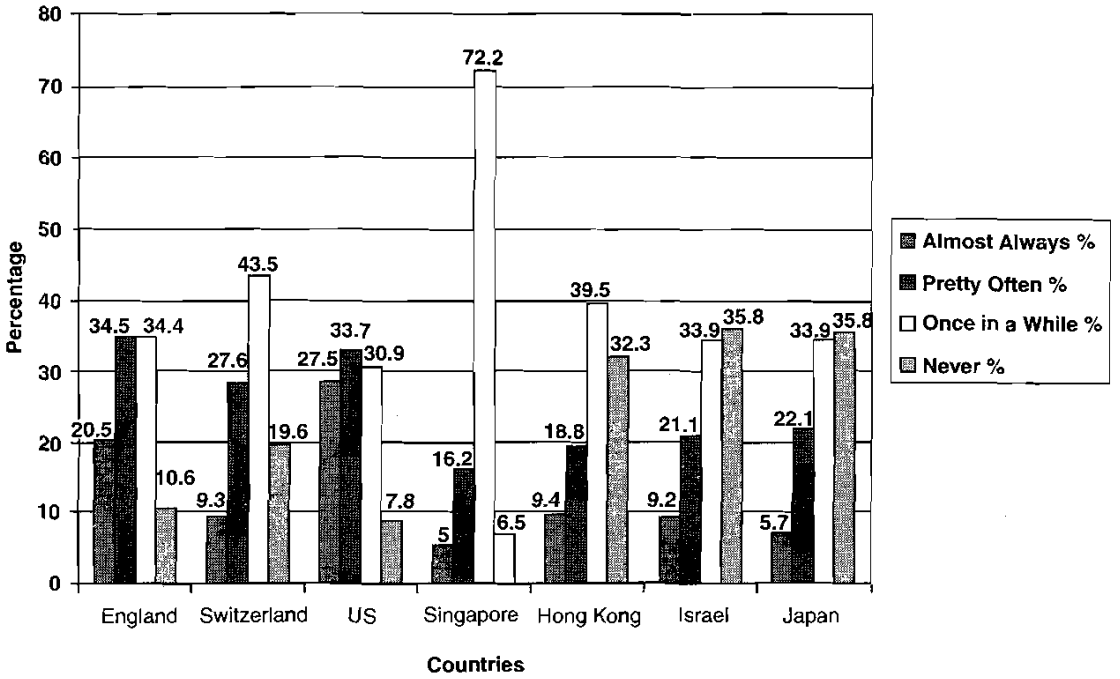

Table 4. Students' response to the question," How often do you work on science projects in your science lesson?" (in percentages)

	England	Switzerland	US	Singapore	Hong Kong	Israel	Germany	Japan
Almost Always and Pretty Often	55	36.9	61.3	21.2	28.2	30.2	27.8	
Once in a While or Never	45.0	63.1	38.7	78.8	71.8	69.6	69.7	

The 1995 TIMSS data shows that a higher percentage of students from England (55%) and the US (61%) indicated that they have worked on science projects almost always or pretty often. In contrast in Asian countries, including Singapore, less than 30% of the students indicated that they worked on science projects in their science lessons almost always or pretty often.

TIMSS (1995) reported that in science, small group work was used less frequently than other instructional approaches. Teachers reported that working together with the whole class using whole class demonstrations and teaching, or having students work individually with assistance from the teacher, were the most frequently used instructional approaches in science classes. In Singapore since the late 1990's, individual and group project work and interdisciplinary project work to be carried out during curriculum time has been introduced with detailed assessment rubrics and implementation guidelines from the Ministry of Education. It would be interesting to examine if students' responses would be much different as a result of this change.

Implications for Teaching

It is recognized that the achievement in science and mathematics would affect economic productivity in countries by affecting the factors that contribute to it. World-class competence in science and mathematics is essential to compete successfully in today's interdependent global marketplace. Countries have been using the evidence from TIMSS to improve their curriculum, teaching strategies, and resources, and to inform teachers and parents of good practice in other countries.

In summary, let's reiterate a few points that teachers could note from the analysis of data from this study. Students' perceptions of the need to do lots of homework and extra studying at home to do well in science suggest that teachers should set adequate interactive/graded homework assignments for their students so that they can keep up academically and improve their performance in science. Students should be given more opportunities to practise explaining and applying science concepts verbally or on paper in their own words, based on their own understanding and thinking. Teachers should also avoid asking questions based on knowledge and recall of facts, as this would encourage memorization of textbooks and notes. Students' perceptions that their teachers helped them too often with their science problems can be alleviated by teachers gradually helping their students develop the skills of note taking and making their own notes. They should conduct more pupil-centred inquiry-based science lessons allowing for more project work and independent study.

Ruth Chellappah is an Assistant Professor attached to the Science and Technology Education Academic Group, National Institute of Education, Nanyang Technological University. E-mail: rchell@nie.edu.sg

Toh Kok Aun is an Associate Professor and Head of the Science and Technology Education Academic Group, National Institute of Education, Nanyang Technological University. E-mail: katoh@nie.edu.sg

Boo Hong Kwen is an Associate Professor, attached to the Science and Technology Education Academic Group, National Institute of Education, Nanyang Technological University. E-mail: hkboo@nie.edu.sg

Khoo Tse Horng is an Education Officer attached to West Spring Secondary School, Singapore.

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