THE USE OF JIGSAW IN PRIMARY SCIENCE: WHAT DO YEAR 5 CHILDREN SAY ON ITS INFLUENCE ON THEIR ATTITUDES TOWARDS SCIENCE

[1]Chan Wai Yin, [2]Ong Eng Tek, [3]Sabri Mohd Salleh
[1]SJK(C) Phin Min
[2, 3]Universiti Pendidikan Sultan Idris

Abstract

This research was conducted to qualitatively gauge the influence of the use of Jigsaw in the teaching and learning of primary science on students' attitudes towards science. A total of 12 Year-5 students (9 girls and 3 boys) in a low enrolment school or its Malay equivalent, *Sekolah Kurang Murid* (SKM) classified by the Ministry of Education as schools with less than 150 students were involved in this research. The two-week intervention consisted of three cycles of Jigsaw in the learning of primary science. Basically, one cycle of Jigsaw entails students working in their respective home groups, students moving to their respective expert groups to work on the teacher-prepared tasks, and students returning to their respective home groups to take turn to share what they have learned in their respective expert groups. Pre- and post-intervention interviews were conducted with six of the Year-5 students. The interviews were transcribed and analyzed through a recursive process. While the analysis of the pre-intervention interview data indicates students' disinterest towards science, the analysis of the post-intervention interview data indicates a crystallization of two major themes which support the claim that students' attitudes towards science has been increased as the outcome of using Jigsaw: Cooperative Activities and Looking Forward to Learning Science.

Keywords *Jigsaw, primary science, attitudes towards science, interview.*

Abstrak

Kajian ini dilaksanakan untuk menentukan pengaruh, secara kualitatif, penggunaan Cantuman atau Jigsaw dalam pengajaran dan pembelajaran sains sekolah rendah terhadap sikap murid terhadap sains. Seramai 12 orang murud Tahun 5 (9 perempuan dan 3 lelaki) di sebuah Sekolah Kurang Murid (SKM) yang diklasifikasi oleh Kementerian Pendidikan Malaysia sebagai sekolah yang mempunyai kurang daripada 150 orang murid terlibat dalam penyelidikan ini. Intervensi selama dua minggu ini terdiri daripada tiga kitaran Jigsaw dalam pembelajaran sains sekolah rendah. Pada dasarnya, satu kitaran Jigsaw melibatkan murid bekerjasama dalam kumpulan dasar (*home groups*), murid bergerak ke kumpulan pakar (*expert groups*) masing-masing untuk menyelesaikan tugasan yang telah disediakan oleh guru, dan murid bergerak balik ke kumpulan dasar masing-masing serta mengambil giliran untuk berkongsi apa yang telah mereka pelajari dalam kumpulan pakar. Temu bual pra dan pasca intervensi diadakan dengan enam orang murid Tahun 5. Temu bual tersebut ditranskipsi dan dianalisiskan melalui satu proses pengulangan. Sementara penganalisisan data temu bual pra intervensi menunjukkan murid tidak meminati sains, penganalisisan data temu bual pasca intervensi menunjukkan satu penghabluran dua tema utama yang menyokong hujah bahawa sikap murid terhadap sains telah bertambah hasil daripada penggunaan Jigsaw: Aktiviti-aktiviti kerjasama, dan mendalami pembelajaran sains.

Kata kunci *Jigsaw, sains sekolah rendah, sikap terhadap sains, temu bual.*

INTRODUCTION

The Malaysian Ministry of Education has made Science as one of the core subjects to be taught in all primary schools, given its importance in contributing towards the realization of 'Vision 2020'. It is envisaged that Malaysia, by the year 2020, would have achieved the status of a developed country, attaining world status in terms of "its economy, national unity, social cohesion, social justice, political stability, system of government, quality of life, social and spiritual values, national pride and confidence" (Lee, 1999, p. 87). Accordingly, the teaching and learning of science in schools should take into account pedagogical approaches which not only will enhance students' meaningful understanding of science concepts, but also will promote, among others, national unity and social cohesion.

The international "report card" which shows the comparative achievement of Malaysian students in science comes from various international studies such as Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA). While TIMSS data have been collected from students at grades 4 and 8 since 1995 every four 4 years, Malaysia participated only since 1999 at grade 8. Table 1 depicts the Malaysia's ranking over the 4 cycles of TIMSS as compared to the International Average. As shown in Table 1, while Malaysia's ranking in science achievement increased slightly between TIMSS 1999 (ranked 22nd) and TIMSS 2003 (ranked 20th), and decreased slightly between TIMSS 2003 (ranked 20th) and TIMSS 2007 (ranked 21st), there was a sharp decline in terms of rank and score which was way below the international average in TIMSS 2011 (ranked 32nd) as compared to TIMSS 2007.

As depicted in Figure 1, it is rather alarming to note that Malaysia's average score has seen a marked decline from a high of 510 (above the benchmark score of 500) to a low of 426 in 2011, placing Malaysia in the bottom 3rd of the TIMSS 2011 study for science. If we were to delve deeper into the distribution of the marks in which the TIMSS study breaks down the Performance of children into 4 general categories, namely Advanced, High, Intermediate, and Low International Benchmarks as depicted in Figure 2, it is much more alarming.

The Advanced International Benchmark with a cut off score of at least 625 is a category where students have demonstrated the ability to "communicate an understanding of complex and abstract concepts in biology, chemistry, physics, and earth science." (Martin, Mullis, Foy, & Stanco, 2012, p.111). In a nutshell, these are the future intellectuals of the country. For the case of Malaysia, just 1% of the 8th grade student population fit the bill, as compared to 40% in Singapore. This 1% of the 8th grade Malaysian students at the Advanced International Benchmark is in stark contrast to the 5% of their counterparts who managed to score advanced scores in 2003. What has happened to the teaching and learning of science that contributed to the attrition of these 4%?

Meanwhile, in the High International Benchmark with a cut off score of at least 550 where students have demonstrated an "understanding of concepts related to science cycles, systems, and principles. …" (Martin et al., 2010, p.111), only 11% of Malaysian 8th grade students fit this category, down from a high of 28% in 2003. In other words, more than a quarter of our students demonstrated a high understanding of Science as indicated in TIMSS 2003 and now, it is just over a 10th of the student population.

In the Intermediate and Low International Benchmarks with the corresponding cut off scores of 475 and 400, the picture seems even more depressing. It used to be that 75% of our students demonstrated at least an intermediate understanding of science, and 95% of students demonstrating at least a low. Now, just 34% of students have an intermediate understanding of science, and merely 62% have a low understanding. This translates to mean that a full 38% of our student population do not even have a basic understanding of science, and failed to achieve at least a 400 score of Low International Benchmark. In other words, almost 40% of our Form 2 students are scientifically illiterate and failed to demonstrate even the competencies stipulated for Low International Benchmark.

> *Students can recognize some basic facts from the life and physical sciences. They have some knowledge of biology, and demonstrate some familiarity with physical phenomena. Students interpret simple pictorial diagrams, complete simple tables, and apply basic knowledge to practical situations.*
>
> (Martin et al., 2011, p.111)

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Table 1 Malaysia's Achievement in TIMSS Grade 8 Science over 4 Cycles

TIMSS 1999			TIMSS 2003			TIMSS 2007			TIMSS 2011		
Rank	Country	Score	Rank	Country	Score	Rank	Country	Score	Rank	Country	Score
1	Taipei	569	1	S'pore	578	1	S'pore	567	1	S'pore	590
2	S'pore	568	2	Taipei	571	2	Taipei	561	2	Taipei	564
3	Hungary	552	3	Korea	558	3	Japan	554	3	Korea	560
4	Jepun	550	4	HKong	556	4	Korea	553	4	Japan	558
5	Korea	549	5	Estonia	552	5	England	542	5	Finland	552
	⋮			⋮			⋮			⋮	
			20	M'sia	510						
						21	M'sia	471	21	Turkey	483
22	M'sia	492							International Average		
International Average										⋮	
23	Lithuania	488									
			International Average			International Average					
			26	Moldovo	472	26	Bahrain	467			
									32	M'sia	426

Figure 1 Trends in Science Achievement for Malaysia
Source: (Martin, Mullis, Foy, & Stanco, 2012, p.62)

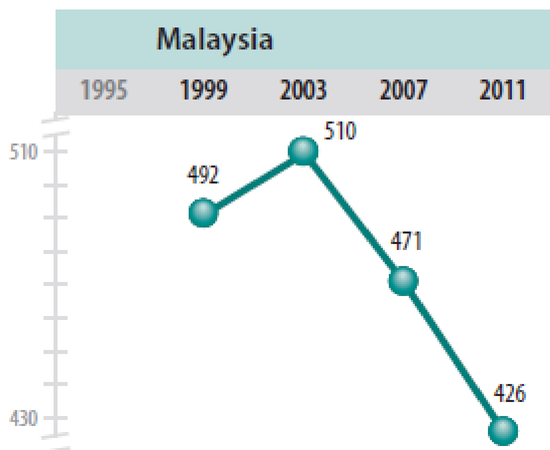

Figure 2 Performance at International Benchmark of Science Achievement
Source: (Martin, Mullis, Foy, & Stanco, 2012, p.114)

Exhibit 2.18: Performance at the International Benchmarks of Science Achievement

TIMSS 2011 Science 8th Grade

Country	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
2 Singapore	40 (1.7)	69 (2.0)	87 (1.6)	96 (0.7)
Chinese Taipei	24 (1.4)	60 (1.2)	85 (0.8)	96 (0.4)
Korea, Rep. of	20 (0.9)	57 (1.1)	86 (0.7)	97 (0.4)
Japan	18 (1.1)	57 (1.3)	86 (0.9)	97 (0.4)
2 Russian Federation	14 (1.1)	48 (1.8)	81 (1.2)	96 (0.7)
‡ England	14 (1.5)	44 (2.6)	76 (2.3)	93 (1.2)
Slovenia	13 (0.8)	48 (1.4)	82 (1.2)	96 (0.5)
Finland	13 (1.2)	53 (1.7)	88 (1.0)	99 (0.3)
3 Israel	11 (1.1)	39 (1.7)	69 (1.7)	88 (1.1)
Australia	11 (1.6)	35 (2.5)	70 (2.0)	92 (0.8)
2 United States	10 (0.7)	40 (1.3)	73 (1.1)	93 (0.7)
Hong Kong SAR	9 (1.1)	47 (1.8)	80 (1.7)	95 (1.0)
New Zealand	9 (1.0)	34 (2.2)	67 (2.2)	90 (1.2)
Hungary	9 (0.8)	39 (1.5)	75 (1.4)	92 (0.8)
Turkey	8 (0.9)	26 (1.4)	54 (1.4)	79 (1.0)
Sweden	6 (0.5)	33 (1.3)	68 (1.4)	91 (0.7)
1 Lithuania	6 (0.7)	33 (1.4)	71 (1.3)	92 (0.6)
Ukraine	6 (0.8)	29 (1.7)	64 (1.6)	88 (1.1)
Iran, Islamic Rep. of	5 (0.7)	21 (1.3)	50 (2.0)	79 (1.5)
United Arab Emirates	4 (0.4)	19 (0.8)	47 (1.1)	75 (0.9)
Italy	4 (0.5)	27 (1.4)	65 (1.4)	90 (1.1)
Kazakhstan	4 (0.6)	23 (1.9)	58 (2.5)	86 (1.2)
Bahrain	3 (0.3)	17 (0.7)	44 (1.0)	70 (0.7)
Qatar	3 (0.5)	14 (1.1)	34 (1.4)	58 (1.2)
Norway	3 (0.4)	22 (1.2)	62 (1.4)	90 (1.1)
Romania	3 (0.5)	16 (1.3)	47 (1.5)	78 (1.5)
Jordan	2 (0.3)	15 (1.0)	45 (1.5)	72 (1.5)
Macedonia, Rep. of	2 (0.4)	10 (1.0)	30 (1.7)	53 (2.0)
Oman	2 (0.2)	11 (0.5)	34 (1.0)	59 (1.3)
Armenia	1 (0.2)	12 (0.8)	37 (1.5)	66 (1.3)
Malaysia	1 (0.4)	11 (1.4)	34 (2.4)	62 (2.6)
Thailand	1 (0.5)	10 (1.3)	39 (2.1)	74 (1.7)
Chile	1 (0.2)	12 (0.9)	43 (1.4)	79 (1.5)
Palestinian Nat'l Auth.	1 (0.2)	10 (0.8)	33 (1.3)	59 (1.3)
Lebanon	1 (0.2)	7 (0.8)	25 (2.0)	54 (2.3)
Saudi Arabia	1 (0.2)	8 (0.8)	33 (2.0)	68 (1.8)
1 Georgia	0 (0.1)	6 (0.6)	28 (1.5)	62 (1.5)
Syrian Arab Republic	0 (0.1)	6 (0.8)	29 (1.8)	63 (1.9)
Tunisia	0 (0.1)	5 (0.7)	30 (1.4)	72 (1.3)
Indonesia	0 (0.1)	3 (0.4)	19 (1.4)	54 (2.3)
Morocco	0 (0.0)	2 (0.2)	13 (0.7)	39 (1.0)
Ψ Ghana	0 (0.1)	1 (0.2)	6 (0.8)	22 (1.7)
International Median	4	21	52	79

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

Ж Average achievement not reliably measured because the percentage of students with achievement too low for estimation exceeds 25%.
Ψ Reservations about reliability of average achievement because the percentage of students with achievement too low for estimation does not exceed 25% but exceeds 15%.
See Appendix C.3 for target population coverage notes 1, 2, and 3. See Appendix C.9 for sampling guidelines and sampling participation notes †, ‡, and ‡.
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

In view of the dismal performance of Malaysian 8th grade students in TIMSS 2011, it sounds an alarm bell for the Malaysian Ministry of Education to strategise with the aim of improving the quality of science and mathematics teaching in the country, particularly in raising the science achievement.

Research in science achievement reveals that there is a strong association between science achievement and attitudes towards science (e.g., Nuttall, 1971; Osborne, Simon, & Collins, 2003; Simpson & Oliver, 1990; Papanastasiou & Zembylas, 2004). In TIMSS 2011 International Science Report (Martin et al., 2012), students' attitudes towards science was one of the ways to elicit information that could provide an educational context for interpreting the science achievement results. The work by Germann (1988) indicates that students who have more positive attitudes towards science show increased attention to classroom instruction and participate more in science activities. The development of attitudes towards science in schools, particularly among elementary school children, is regarded as important because positive attitudes may contribute to the increased uptake of science. Research also indicates that many latent scientists appear to make early decisions about their careers in the elementary years (Blatchford, 1992; Wellington, 1990; Woolnough, 1990).

Therefore, the development of positive attitudes towards science is one of the legitimate goals of science education globally. Although attitudinal research has been conducted amongst students at secondary and pre-university levels in Malaysia (e.g., Kamisah, Zanaton, & Lilia, 2007; Ong & Ruthven, 200; Zanaton, Lilia, & Kamisah, 2006), there is still a scarcity in attitudinal research amongst students at the elementary level. Accordingly, this study aims to illuminate the research question: What do the year 5 students say with regard their attitudes towards science after undergoing the three cycles of Jigsaw cooperative learning?

Jigsaw: A Review

Cooperative learning refers to generic instructional methods in which students of all levels of achievement, be they low, average, or high-achieving students, work together as a team and assist each other in solving problems, completing a task, or accomplishing a common goal (Gillies, 2006; Slavin, 1986, 1991, 1998). In fact, cooperative learning is an umbrella term for a plethora of educational approaches involving joint intellectual effort among students (Delucchi, 2006).

There is a wide plethora of cooperative learning strategies which can be employed in classroom teaching to enhance students' understanding of the curriculum content. In essence, these cooperative learning strategies could be categorised into the following approaches: (1) The Structural Approach (Kagan, 1990; 1994) which comprises a range of structures such as RoundRobin, RoundTable, Think-Pair-Share, Think-Pair-Square, Numbered-Heads-Together, Showdown, Corners, Mix-N-Match, and Formation; (2) The Conceptual Approach which is also known as Circles of Learning (Johnson et al., 1984), or previously, Learning Together (Johnson & Johnson, 1975); (3) Group Investigation (Sharan et al., 1984, Sharan & Hertz-Lazarowitz, 1980; Sharan & Sharan, 1976); (4) The Curricular Approach which encompasses the various strategies subsumed under the Student Team Learning that includes Student Teams-Achievement Divisions or STAD (Slavin, 1978, 1986), Teams-Games-Tournament or TGT (DeVries & Slavin, 1978; Slavin, 1986), Team Assisted Individualization or TAI (Slavin, Leavey, & Madden, 1986), Cooperative Integrated Reading and Composition or CIRC (Madden, Steven, & Slavin, 1986), and Jigsaw II (Slavin, 1980), which is a modification of original Jigsaw (Aronson et al., 1978).

In terms of students' attitudes towards the Jigsaw method, generally, students of all ages and levels find the Jigsaw method to be enjoyable and beneficial experience (Aronson, 2005; Dori et al., 1995; Fennel, 1992). Dori et al., (1995) discovered that students who were taught using the Jigsaw expressed a willingness to use the strategy again in future lessons and also recommended that Jigsaw method be employed with their peers in other classes. By means of surveying 208 students who had been taught both Jigsaw method and lecture format, Fennel (1992) discovered that 99.05% of the students enjoyed Jigsaw experience and found such experience to be useful. Meanwhile, Aronson (2005) found that students who were taught using Jigsaw method were less likely to be absent from school as compared to other students. Rosmarina Jamaludin (2014) investigated the effects of the Jigsaw method and found that, while there was no impact on the university students' understanding of Biology concepts, their critical thinking skills were enhanced as the outcome of using Jigsaw.

METHODOLOGY

Research Design

This study employed a one-group pre-intervention interview and post-intervention interview design. Such design was chosen on the basis of the availability of an intact classroom in a natural ecological environment without disruption to classroom learning (Creswell, 2008) and also the non-feasibility of statistical analysis due to a small sample size by virtue of the low-enrolment school. Furthermore, by operating in a qualitative paradigm, students' voices with regard to their attitudes towards science could be heard.

Sampling

Using a convenient sampling, an intact year 5 classroom consisting of 12 students (3 males, 12 females) from a low-enrolment National-typed Primary School situated in the state of Perak was selected. In terms of ethnicity, there were 4 Malay females while the others were of Chinese ethnicity.

Instrumentation

An interview protocol seeking to procure students' attitudes towards science was developed. In particular, students were asked to: (1) enumerate the activities which they enjoyed during the teaching and learning in science, (2) state if they enjoyed the Jigsaw cooperative learning activities, and why; and (3) describe their anticipation, if there is any, towards learning of science. In pre-intervention interview, only questions (1) and (3) were posed, while in post-intervention interview, all the three questions were asked.

Data Collection Procedure

Consent for involvement and permission to audiotape were sought from the students as part of the research ethics. Prior to the commencement of the intervention, 6 students were interviewed with regard to the attitudes towards science. The three cycles of Jigsaw intervention were given, with each cycle covering one of the topics, namely sources of energy, forms of energy, and renewable and non-renewable energy

(Bahagian Pembangunan Kurikulum, 2014). In each cycle of Jigsaw, students, placed in their respective Home Groups with each consisting of four students labeled as A, B, C & D, were given differing tasks or discussion questions. Then, they moved to their respective Expert Groups and discussed the specific task or questions assigned. Finally, students returned to their respective Home Groups, each taking turn to report what has been discussed and learned in their Expert Group. After the three cycles of Jigsaw intervention, the earlier six students were re-interviewed.

Data Analysis Procedure

The pre-intervention and post-intervention interviews were transcribed. Through a recursive process, the pre-intervention interview transcripts were first coded, and this was followed by the coding of post-intervention interview transcripts. The codes or themes were then qualitatively compared so as to gauge students' attitudes towards science.

RESULTS

The analysis of the pre-intervention interview data generally indicates students' disinterest towards science, echoing in unison as supported by the following verbatim quotations in which R refers to the respondent (student) and the number which follows R indicates the label for a particular student:

I am really not interested in science. (R1)
I am not interested in science. (R2 & R5)
I am totally not interested in science. (R3)
No, [I am not interested in science]. (R4)
No, I dislike science. (R6)

Such a disinterest in science is further corroborated by their non-disposition towards science in that they do not look forward to having a science lesson. The following verbatim quotations seem to support the non-disposition towards science among these year 5 students:-

No, I look forward to English class. (R1)
I do not have any happy feelings towards science class. (R2)
I am not looking forward to the science class. (R3)
No, I dislike science class. (R4)
If the [science] teacher [is] absent, I will [be] happy because I don't want to learn science. (R5)
No [I don't like science]. If the teacher does not enter my class, I can do my own homework. (R6)

The analysis of the post-intervention interview data, by contrast, indicates a crystallization of two major themes which support the claim that student' attitudes towards science has been increased as the outcome Jigsaw: Cooperative Activities and Looking Forward to Learning Science.

Theme 1: Cooperative Learning Activities

Students were very captivated by the cooperative learning activities which they generally verbalised as "group activities" and reckoned that through such activities, they could discuss together and were helped by such a discussion with their friends. Consequently, their attitudes towards science were enhanced. Such contention is supported by the following verbatim quotations:-

Group activity, this is what I like. This is because I can do work with my friends. They helped me to understand what I cannot understand. I don't like to learn alone. (R1)
I am interested in group activity … The activity that teacher gave allowed me to ask my friends. I am very happy to ask friends. (R2)
The group activity that we did really interests me because I am not lonely. We can ask each other and answer together. (R3)
I like doing the activity … discussion activity. (R4)
I like the group discussion activity. The questions given by teacher were interesting and we found the answers through discussion. (R5)
I like the experimental activity which teacher prepares. I can conduct the experiment with my friends and we got the answers together. (R6)

Theme 2: Looking Forward to Learning Science

Students' attitudes towards science were enhanced as evident in their anticipation for the coming science lessons. In other words, students were in unison in stating that they were looking forward to having and learning science as supported by the following quotations:-

Every day, I wait for teacher to come in to teach science. I like your class. (R1)
I will straight away call you (i.e., the science teacher) if you come late to class. I like learning science and I wait for your interesting activity. (R3)
I keep away all other books and only take out science book before teacher comes in. I like to learn more about science. (R5)
I always sit quietly and wait for you (i.e., the science teacher) to come. If my friends are noisy, I will ask them to keep quiet. With that, I have more opportunity to learn science. (R6)

DISCUSSION AND CONCLUSION

The findings of this study indicate that students who had followed through the three cycles of Jigsaw science lessons were more positive in their attitudes towards science as supported by the analysis of interviews which crystallizes the interview data into two themes, namely Cooperative Learning Activities and Looking Forward to Learning Science. Therefore, in the teaching of science, it is strongly recommended to use Jigsaw cooperative learning, because children enjoy working in groups and they feel that they learn better from their peers.

The attitudinal enhancement outcome in this study, by logic of parallel impact of the effect from Jigsaw cooperative learning method, is consistent with the research findings of Siti Rahayah (1998), and Nor Azizah et al., (2001). The increased responsibility towards friends, particularly in terms of assisting each other within a cooperative learning group is consistent with the findings by Krause, Stark dan Mandl (2009). Additionally, the use of Jigsaw cooperative learning increases the student-student interaction in the classroom through discussion, and this finding is consistent with the findings of Veenman et al., (2002).

The qualitative findings of this study were derived from only 12 year 5 students of one low-enrolment primary school; hence its limitation in terms of generalisability. Accordingly, as an implication for future research, it is strongly recommended that further studies investigating similar impact of Jigsaw cooperative learning method using a larger, more representative sample and operating in a quantitative paradigm so as to further validate the attitudinal outcomes of using Jigsaw in the learning of primary science, be conducted.

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