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Exploring Attitudes Towards Science Among Malay and Aboriginal Primary Students

Eng Tek ONG[1], Norjuhana MESMAN[2], Koon Peng YEAM[3]

[1]Dr., Sultan Idris Education University, Tanjung Malim, Perak-MALAYSIA
[2] Bolok Lanchang National Primary School, Temerloh, Pahang-MALAYSIA
[3]Khir Johari National Secondary School, Tanjung Malim, Perak-MALAYSIA

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ABSTRACT

This study aims to explore the gender, grade level and ethnicity differential in attitudes towards science. Using a 3-point Likert scale 8-item unidimensional Attitudes Towards Science Questionnaire with appropriate validity and reliability, the questionnaire was administered to 84 respondents from two national primary schools in Temerloh District in Pahang comprising 29, 25 and 30 primary students from years 4, 5 and 6 respectively. The dataset was analysed using a two-way (gender and grade level) factorial ANOVA and an independent samples t-test for ethnicity. The findings indicated that while there were no significant two-way interactional effect and main gender effect, the grade level effect was significant in which Year 5 and 6 students were having more positive attitudes than Year 4 students. Additionally, the Malay students have a markedly higher level of attitudes towards science as compared to the Aboriginal students. The results are discussed in the context of science teaching and research.

Keywords: Attitudes towards Science; Malay; Aboriginal; Primary Students.

INTRODUCTION

Scientific literacy, probably the most commonly use terms in science education today (Roberts, 2007), has been one of the main goals of science education in many countries across the globe. The National Philosophy of Science Education in Malaysia embodies the aspiration to develop scientific literacy among Malaysians by fostering "a culture of Science and Technology, focusing on the development of an individual who is competitive, dynamic, agile and resilient, and is able to master the knowledge of science and technological competence" (Ministry of Education, 2010, p. v). While there is virtually no consensus on the definition of scientific literacy and it has been hailed as "an ill-defined and diffuse concept" by Laugksch (2000, p.71), the characteristics of a scientifically literate person, as described in the Twenty First Century Science (u.d.) – a suite of science courses offered at GCSE in the UK, encompass the ability to appreciate and understand the impact of science and technology on everyday life; take informed personal decisions about things that involve science, such as health, diet, use of energy resources; read and understand the essential points of media reports

Corresponding author e-mail: ong.engtek@fppm.upsi.edu.my

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about matters that involve science; reflect critically on the information included in, and (often more important) omitted from, such reports; and take part confidently in discussions with others about issues involving science.

Accordingly, scientific literacy involves not only the cognitive domain, but also the affective or attitudinal domain which deals with appreciation, taking informed personal decisions, and taking part confidently in discussions on scientific issues. Hence, scientific literacy is affected by a student's attitudes towards science, which in turn, contributes to how well he or she performs in a science class (Dalgety, Coll & Jones, 2003; George, 2000). Research also indicates that prior learning of, and past exposure to, science-based subjects do have an impact on science achievement and attitudes (Baldwin, Ebert-May, & Burns, 1999; Wandersee, Mintzes, & Novak, 1994).

Research in academic achievement reveals that there is a strong association between science achievement and attitudes towards science (e.g., Nuttall, 1971; Simpson & Oliver, 1990; Papanastasiou & Zembylas, 2002; 2004). In TIMSS 2011 International Science Report (Martin, Mullis, Foy, & Stanco, 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 and the sufficiency of scientists. Osborne, Simon, and Collons (2003) opine that "educating more children in mathematics and science is, at the very least, very unlikely to have a negative effect on the economic well-being of any society" (p. 1053) and research 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., Ahmad Nurulazam, Mohd Ali, Rohandi, & Azman, 2010; Aziz & Lin, 2011; Kamisah, 2013; Kamisah, Zanaton, & Lilia, 2007; Ong & Ruthven, 2009; Zanaton, Lilia, & Kamisah, 2006), there is still a scarcity in attitudinal research amongst students at the elementary level.

Aims

This study aims to investigate the attitudes towards science among elementary school students, looking at the differences by gender, grade level, and ethnicity. Ethnicity difference is worth investigating given that there are some aboriginal (indigenous) students among the predominantly Malay students in the selected schools. Accordingly, this study seeks to answer the following questions:-

(a) Is there any difference in attitudes towards science between the girls and the boys?
(b) Are there any differences in attitudes towards science among the students in grades 4, 5 and 6?
(c) Is there a difference in attitudes towards science between the aboriginal and the Malay students?

Attitudes towards science: A literature review

The concept of attitude and its relation to academic achievement has been the targeted area of educational research since 1920s when Thurstone declared in an article that attitudes were measurable (Simpson, Koballa, Oliver, & Crawley, 1994). From 1920s till the early

1970s, the scope of attitudinal research was in one of the three areas, namely measurement of student attitudes; measurement of change in student attitudes resulting from various interventions or treatment methods; and identification of relationship in support of student attitudes and science-related behaviours (Simpson et al., 1994). In the late 1970s and early 1980s, attitudinal research “focused on documenting student attitudes and their relationship to science achievement” (Koballa & Glynn, 2007, p.77). While there seemed to be a pause in attitudinal research in the 1990s, possibly due to uncharted direction, the first decade of the 21st Century displayed an uptrend in attitudinal research which looks into “a variety of student attitudes and beliefs that shape and are shaped by student classroom experience” (Adams, Perkins, Podolefsky, Dubson, Finkelstein, & Wieman, 2006, p. 1). Such growth in attitudinal research was due, in part, to the concern among science educators and researchers regarding the decreasing uptake of science post-16, which correspondingly, causing a significant decline in the number of students in the scientific career pipeline (Osborne, Simon, & Collins, 2003) which was described as “a murky pool of talent” by The Royal Society (2006, p.3).

Gardner (1975) acknowledges the broad nature of the term attitude that takes on different meanings in discussions about science education. He distinguishes two broad categories of attitude. The first category, "attitudes towards science" (e.g., interest in science, attitudes towards scientist, attitudes towards social responsibility in science) shows some distinct attitude object such as science or scientist, to which the respondent is invited to react favourably or otherwise. Viewed as an emotional reaction of students, Gardner (1975, p.2) regards attitudes towards science as "learned disposition to evaluate in certain ways objects, actions, situations or propositions involved in the learning of science". The second category, "scientific attitudes" (e.g., open-mindedness, objectivity, honesty, and skepticism), by contrast, are best described as styles of thinking which scientists are presumed to display. In a similar vein of differentiating, Simpson et al. (1994) reckon scientific attitudes as “ways in which scientists believe in and conduct their work” (p.212), while attitudes towards science represent “a person’s positive or negative response to the enterprise of science ... [or] refer specifically to whether a person likes or dislikes science” (p.213). Osborne, Simon, and Collins (2003) subscribe to Gardner's distinction between "attitudes towards science" and "scientific attitudes", reckoning such distinction as not only clear, but "fundamental and basic" (p.1053) in an otherwise "nebulous, …poorly articulated and not well understood" (p. 1049) concept of attitudes in science educational research.

The review of research into attitudes towards science by Osborne, Simon, and Collins (2003, p.1054) indicate that the attitudes towards science are multidimensional in terms of construct, and that the subconstructs, which contribute in varying proportions towards an individual’s attitudes towards science, consist of the combination of these measures: the perception of the science teacher; anxiety toward science; the value of science; self-esteem at science; motivation towards science; enjoyment of science; attitudes of peers and friends towards science; attitudes of parents towards science; the nature of the classroom environment; achievement in science; and fear of failure on course.

Nevertheless, the problem of interpreting the significance of these subconstructs or sub-dimensions of attitudes towards science has been pertinently pointed out by Gardner (1975) when he comments: “An attitude instrument yields a score. If this score is to be meaningful, it should faithfully reflect the respondent’s position on some well-defined continuum. For this to happen, the items within the scale must all be related to a single attitude object. A disparate collection of items, reflecting attitude towards a wide variety of attitude objects, does not constitute a scale, and cannot yield a meaningful score” (p. 12). Accordingly, Gardner (1975) strongly advocates that when measuring attitudes toward science, the instrument used needs to be internally consistent and unidimensional. While internal consistency is commonly determined through the use of a measure known as Cronbach’s alpha, the unidimensionality of scales are tested using an appropriate statistical technique such as factor analysis. Osborne, Simon, and Collins (2003) reinforced Garner's (1975) advocacy by cautioning that "while unidimensional scales will be internally consistent (since they all measure the same construct), it does not follow that internally consistent scales will be unidimensional" and reminding researchers that "if a scale does measure what it purports to measure, then the variance should be explained by a loading on a unitary factor" (p. 1058).

A clear feature of the attitudinal research is the decline in attitudes towards science from age 11 onwards. Yager and Penick (1986) found that students in elementary schools perceived science to be enjoyable, interesting and useful. However, a decline in attitude occurs throughout junior high and high school, resulting in young adults who do not feel positive about their school science. Osborne, Driver, and Simon (1998) noted that positive attitudes towards school science appear to peak at, or before, the age of 11 and decline thereafter by quite significant amounts, especially for girls. Lowery (1967) found that at the age of 10 to 11, science in children's mind was associated with difficult words, monsters, precious metals and jewels, and that science was unsafe. The results of the national survey in Australian schools undertaken by Rennie, Goodrum, and Hackling (2001) indicate that a significant number of adolescents view science as a difficult and boring subject.

Another clear feature of the attitudinal research, supported by meta-analyses of Schibeci (1984), Becker (1989), and Weinburgh (1995), and by subject preference study of Lightbody and Durndell (1996) in one school is that boys have a consistently more positive attitudes towards school science than girls. The plausible thesis offered to explain this finding is that it is a consequence of "stereotype threat" (Hill, Corbett, & St. Rose, 2010, p. 38) whereby boys are generally being perceived as better suited and possessing higher ability for science careers than girls. Such thesis is supported by Corell (2004) whose study indicates that fewer girls than boys are interested in becoming scientists or engineers, and by Jovanovic and King (1998) who contend that girls' antipathy towards science is explained by their own comparative judgments across academic domains, perceiving that they are better at other subjects (i.e., English) and, therefore, not as good at science.

However, while boys' attitudes towards science are significantly more positive than girls, the effect is stronger in physics than in biology. Such a bifurcation of interest in physical and biological science between boys and girls (i.e., Harvey & Edwards, 1980) has been given additional salience by the work of Ormerod, Rutherford, and Wood (1989) where boys were found to be far more interested in "space" and girls far more interested in "nature study". Meanwhile, by employing the use of focus groups to explore 16-year-old student's views and attitudes towards science, Osborne and Collins (2000) found that, to their surprise, chemistry was perceived as less appealing than physics, although the analysis by gender in Osborne, Simon, and Collins (2003) shows that the male to female ratio is approximately equal in chemistry as compared to 3.4:1 in physics, favoring the males, and 1.6:1 in biology, favoring the females.

The work of Jarvis and Pell (2005) suggests that an intervention of visiting UK National Space Centre had positive significant effects on Year 10 and 11 children's attitudes towards science in terms of interest in space, science in a social context, and lowering anxiety. However, there was no significant effect on attitudes with regard to science enthusiasm. As to its long-term effect, while the space interest was not sustained, the attitudes towards science in a social context continued to remain at a high level and that the anxiety levels which showed a much lower score after the visit continued to decline for the remainder of the year. In terms of the impact on attitudes towards science deriving from intervention using student-centered strategies, the results seem to be mixed. While some studies suggest that the use of inquiry-based teaching does have positive impact on students' attitudes towards science (Gibson & Chase 2002; Jones, Gott, & Jarman, 2000; Lord & Orkwiszewski 2006; Sesen &

Tarhan, 2013), other studies concluded that there was no significant impact of activity-based teaching or programmes (e.g., Gantreau & Binns, 2008; Turpin, 2000; Wideen, 1975) on students' attitudes towards science.

Studies reviewed in this section support four conclusions of research on attitudes towards science. Firstly, age is related to attitude (i.e., as a student advances to higher levels of schooling, attitude declines). Secondly, gender is related to attitude (i.e., boys have more positive attitudes towards science than girls). Thirdly, gender is also related to biological science relative to physical science (i.e., boys are more interested in physical science while girls are more interested in biological science). Finally, students' attitudes towards science are related to the pedagogical approach employed by the teachers (i.e., inquiry-based teaching and outdoor science may have positive impact on attitudes towards science). Nevertheless, the review of the literature in this section indicates that, while there is an abundance of attitudinal research conducted among secondary and post secondary students, the research on elementary (primary) students' attitudes towards science is relatively scant and inadequate.

METHODOLOGY

a) Research Design

In view of the aim of this research which is to gauge the level of attitudes towards science among elementary school students, comparing it by gender, grade level, and ethnicity in a natural, intact ecological school setting, and subsequently, providing possible reasons and explanations for the findings, the appropriate methodology used was a causal-comparative research design. This is in line with the principles in the causal-comparative design where "investigators attempt to determine the cause or consequences of differences that *already exist* between or among groups of individuals" (Fraenkel, Wallen, & Hyun, 2012, p. 366).

b) Instrumentation

The instrument used in this study, a modified version of the Attitudes Towards Science Inventory (m-ATSI), was adapted from the Attitude Toward Science Inventory or ATSI (Gogolin & Swartz, 1992). While the multidimensional ATSI has 48 items measuring six constructs, namely perception of the science teacher, anxiety towards science, value of science in society, self-concept in science, enjoyment of science, and motivation in science, using a 5-point Likert scale of which some items are worded negatively, the m-ATSI is basically an 8-item unidimensional inventory measuring only the construct of enjoyment in science using a 3-point Likert scale where each item is worded in a positive manner. The adaptation took into consideration the age range, reading ability and the concentration time span of upper primary students, and hence it is pre-determined as unidimensional with 8 items using a 3-point Likert scale (1=Disagree, 2=Undecided, 3=Agree). Despite the fact that ATSI was developed in the 90s, the construct measuring students' attitudes towards science in terms of their enjoyment in learning science is still relevant to the Malaysian context as evident in the study by Kamisah (2013).

In order to establish its unidimensionality, a factor analysis was run with the dataset collected from a sample of 84 students. The value of Kaiser-Meyer-Olkin (KMO) obtained was 0.740, suggesting good sampling adequacy (Hutcheson & Sofroniou, 1999) and that factor analysis is appropriate (Field, 2005). Bartlett's test of spherity has a significant value, $p < .001$, indicating that the R-matrix is not an identity matrix, having some relationship between variables, and therefore, factor analysis is appropriate (Field, 2005). The unidimensionality, established through a factor analysis with varimax rotation, was evident in one factor solution with factor loadings that ranged from 0.49 to 0.74 and an eigenvalue of 3.03 which accounted for 37.92 per cent of the total variance. The Cronbach's alpha for m-

ATSI was 0.76, suggesting that the instrument has sufficient internal reliability. Accordingly, the use of the 8-item m-ATSI justifies the use of summated-ratings procedure to measure students' attitudes towards science. Table 1 presents the items in the unidimensional scale for the modified Attitudes Towards Science Inventory (m-ATSI).

Table 1. *Unidimensional Scale for the Modified Attitudes towards Science Inventory (m-ATSI)*

Attitudes Towards Science Inventory (m-ATSI) (α = 0.76)		Factor Loading
1.	Doing science labs or hands-on activities is fun (#6) *Aktiviti dalam makmal sains menyeronokkan*	.646
2.	Science is something that I enjoy very much (#2) *Saya sangat suka sains*	.533
3.	I do not like anything about science (#18)* *Saya tidak suka apa-apa juga yang berkaitan dengan sains*	.589
4.	I enjoy watching a science program on television (#29) *Saya seronok menonton program sains di TV*	.605
5.	I enjoy talking to people about science (#28) *Saya seronok bercakap mengenai sains dengan orang lain*	.742
6.	Working with science upsets me (#34)* *Kerja-kerja berkaitan dengan sains menggembirakan saya*	.699
7.	Science is one of my favourite subjects (#45) *Sains merupakan salah satu mata pelajaran yang saya gemari*	.581
8.	I would like to spend more time in school studying science (#13) *Saya ingin menghabiskan lebih masa untuk mempelajari sains di sekolah*	.492

Note: * reverse-coded item

c) Sampling

A convenience sampling was used in this study given that the second author and her friend taught science in the participating schools. While we acknowledge the criticism of bias and non-representativenes in convenience sampling, such sampling technique, nevertheless, has the benefit of obtaining preliminary data for understanding of attitudinal trend among upper primary students without the complications of using a randomized sample. There were 84 students, drawn from Year 4, 5 and 6 intact classes of two national primary schools in Temerloh, participated in this study. Analisis by gender, there were 49 boys (32 Malay, 17 Indigeneous) and 35 girls (29 Malay, 6 Indigenous). The two participating schools are classified as rural schools by the Ministry of Education and the total number of Year 4, 5 and 6 students as gleaned from the official records was 116, with the Malay and Aboriginal ratio of approximately 3:2. This suggests a high absenteeism, particularly among the aboriginal students who regularly skip school for various reasons which include helping parents in farming. Table 2 presents the number of students by gender and grade level for ethnicity.

Table 2. *Sample Distribution*

	Malay			Indigenous			
Grade Level	Boys	Girls	Total	Boys	Girls	Total	Grand Total
Year 4	11	7	18	8	3	11	29
Year 5	5	12	17	6	2	8	25
Year 6	16	10	26	3	1	4	30
Total	32	29	61	17	6	23	84

d) Data Collection Procedures

The m-ATSI was administered to the students in each class by the second author in school time. Before responding to the items, a moderation session was held with the students in which they were tuned to what it means to agree, undecided, and to disagree by means of a simulation. To simulate or walk through what "agree" means, students were presented a hypothetical situation in which they have just eaten a sumptous lunch till they are really full, and then they were presented with the statement, "I want to have a bowl of noodle". In the same fashion, undecided and disagree responses were simulated through a partially full and hungry (or starving) hypothetical situations respectively. Once students were accustomed or tuned to the three responses, the first item in the m-ASTI was then audibly read to the class, clarifing any question and explaining any meaning of a problematic word or phrase. The students then picked their self-perceived most suitable response by checking the corresponding box. This process was repeated for each of the eight items.

e) Data Analysis Procedures

With the significance level set at 0.05, the scores on m-ATSI were analysed using a 2 x 3 (gender x grade level) ANOVA. The reason for using factorial design was to ensure that the interpretation of gender and grade level differences was not spurious as measure had been taken to establish if there was any two-way interaction effect. Should the interaction effect is significant, then the moderating effect of one independent variable on the other independent variable would be judiciously considered; otherwise, the main effects of gender and grade level could be interpreted in a straightforward manner. Additionally, ethnicity was not entered into the equation for three-way factorial ANOVA simply because the number of Aboriginal students was small and should it be entered into a three-way factorial analysis, some cells would have less than 5 cases as indicated in Table 2, thus rendering the analysis as non-robust. As such, the difference in attitudes towards science by ethnicity would be analysed separately using an independent samples t-test.

FINDINGS

A two-way ANOVA for attitudes towards science was carried out. The results are presented in Table 3.

Table 3. *2 x 3 (Gender x Grade Level) between-subjects Analysis of Variance for attitudes towards science*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Gender (A)	13.575	1	13.575	1.151	.287	.015
Grade Level (B)	185.339	2	92.669	7.856	.001	.168
A * B	5.744	2	2.872	.243	.784	.006
Error	920.038	78	11.795			
Total	29243.000	84				
Corrected Total	1119.560	83				

One-Way Gender Effect

Based on Table 3, the main effect of gender was not significant, $F(1, 78) = 1.151$, $p = .287$. Table 4 shows the means and standard deviations by gender for attitudes towards science.

Table 4. *Means and Standard Deviations by Gender for Attitudes towards Science*

	Boys (n=49)		Girls (n=35)		Difference
	M_m	SD	M_f	SD	$M_m - M_f$
attitudes towards science	18.49	4.13	18.03	2.96	0.46

One-Way Grade Level Effect

Based on Table 3, the main effect of grade level was statistically significant, F(2, 78) = 7.856, p = .001 < .05, and accounted for 16.8% of the total variance in the attitudes towards science. Table 5 presents the means and standard deviations by grade level for the attitudes towards science.

Table 5. *Means And Standard Deviations by Grade Level for Attitudes towards Science*

	Year 4 (n=29)		Year 5 (n=25)		Year 6 (n=30)		Differences		
	M_4	SD	M_5	SD	M_6	SD	$M_4 - M_5$	$M_4 - M_6$	$M_5 - M_6$
attitudes towards science	16.28	4.11	19.36	2.69	19.37	3.17	-3.08* p=.004	-3.09* p=.002	-0.01 p=1.000

* Significant at p < .05

When the statistically significant grade level effect was followed up with the Bonferroni Post Hoc Tests for attitudes towards science, significant differences were found between the attitudes of Year 4 and 5 students favouring Year 5, and of Year 4 and 6 students, favouring Year 6. However, the attitudes towards science between Year 5 and 6 students were not statistically significant.

Two-Way Gender and Grade Level Interaction Effect

Based on Table 3, there was no statistically significant effect of interaction between gender and grade level, F(2, 78) = 0.243, p = .784 > .05, for attitudes towards science. The descriptive statistics by gender and grade level for attitudes towards science are given in Table 6.

Table 6. *Means and Standard Deviations by Group and Grade Level for Attitudes Towards Science*

	Boys (n=49)						Girls (n=35)					
	Year 4 (n=19)		Year 5 (n=11)		Year 6 (n=19)		Year 4 (n=10)		Year 5 (n=14)		Year 6 (n=11)	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
attitudes towards science	16.58	4.51	20.18	3.63	19.42	3.36	15.70	3.37	18.71	1.49	19.27	2.97

Ethnicity Effect

The attitudes towards science between the Malay and the Aboriginal students were investigated by performing an independent samples t-test. As shown in Table 7, the analysis of independent samples t-test yielded a t(83) of 3.22 that was statistically significant (*p* <.05). This indicates that the level of attitudes towards science among the Malay students is statistically significantly higher than the level of attitudes among the Aboriginal students.

Table 7. *Results Obtained from İndependent Samples T-Test for Attitudes towards Science*

Malay			Aboriginal				
N	Mean	SD	N	Mean	SD	t	p
61	19.05	3.24	23	16.30	4.06	3.22	.002

DISCUSSION and CONCLUSION

The aims of this research were to explore the differences in attitudes towards science among the Malay and Aboriginal Year 4, 5 and 6 primary students, specifically by gender, grade level, and ethnicity. Since there was no two-way interactional effect between gender and grade level, the main effects for gender as well as grade level could therefore be interpreted in a straightforward manner without any concern of moderating effect. The findings indicated that, while there was no significant difference in attitudes towards science between the boys and the girls, there was a statistical significant difference by grade level in which Year 5 students had more positive attitudes towards science than Year 4 students, and that Year 6 students had more positive attitudes towards science than Year 4 students. However, there was no significant difference in attitudes towards science between Year 5 and Year 6 students. In terms of ethnicity, the Malay students have more favorable attitudes towards science as compared to the Aboriginal students.

The findings of this study in which Year 4 (aged 10 in Malaysia) students' level of attitudes towards science seems to increase as they progress to Year 5 (aged 11) and subsequently hovering around or rather plateuring at similar level in Year 6 (aged 12), provide credence to Osborne, Driver, and Simon's (1998) observation that positive attitudes towards school science appear to peak at, or before, the age of 11. Such parallel findings were rather accidental because the participants in Osborne, Driver, and Simon's (1998) study were geographically, culturally, and socially dissimilar, albeit similar in age. Accordingly, this may suggest similar trend in students' attitudes towards science at ages 10-12 across boundaries, and that such attitudinal trend is not idiosyncratic to Malaysian students. Further study is required to determine if similar trend in attitudes towards science can be found should a more representative sample be used. Morever, this trend in attitudes towards science among the Malay and Aboriginal students can be explained within the context of primary science teaching in Malaysia. One of the possible explanations is that science is introduced as a subject in Year 1 with simple hands-on, minds-on, and hearts-on classroom activities, and these activity-based lessons increase in numbers and complexity in tendem to the cognitive demand as stipulated in the syllabuses. At Years 5 and 6, the teaching and learning of science in the primary classrooms is characterized by note-copying and drilling in preparation for the National Standardised "Primary School Evaluation Test" or its acronym UPSR (*Ujian Penilaian Sekolah Rendah*), and this may contribute towards a stagnated level of attitudes towards science among these Year 5 and 6 students.

The finding in this study which shows no difference in attitudes towards science between the girls and the boys is not consistent with the study of Lightbody and Durndell (1996) and meta-analyses of Schibeci (1984), Becker (1989), and Weinburgh (1995) which indicate that boys have consistently more positive attitudes towards science. The no-gender-difference phenomenon could be explained from a sociocultural perspective. While boys and girls at the primary ages see themselves as members of a group, the group membership seems to be gender inclusive, rather than gender exclusive where the boys see themselves in a masculine group and the girls, feminine group. Gender exclusive perception has been propounded to explain the differences in achievement where boys more than girls reckon that excelling in education as not "cool" (Francis, 2000; Warrington, Younger, & Williams, 2000; Whitelaw, Milosevic, & Daniels, 2000) and that displaying a positive attitudes towards science as not being the "done thing" (Osborne, Simons, & Collins, 2003, p. 1054). By similar vein, it can be theorized that gender inclusive perception which is more dominant among non-adolescent boys and girls, may explain for the non-statistical difference in attitudes towards science by gender. This has implications for science teaching, particularly in structuring group activity, where teachers should make a conscious effort and preparation to ensure that heterogeneous grouping is used in activity-based lessons; heterogeneity not only in terms of academic achievement, but also in terms of gender and ethnicity.

In relation to ethnicity in which the Malay students have more positive attitudes towards science than the Aboriginal students, we were not able to find any previous studies done with which this finding could be directly compared, thus explaining the novelty and distinctiveness of the ethnicity effect of this study. However, there is a cause for concern as the Aboriginal students who responded to the attitudinal questionnaire in this study were the students who did not play truant on that day. What about the level of attitudes towards science among those Aboriginal students who were absent? As such, it would contribute significantly to the research and literature if the future research could determine whether such level of attitudes towards science is reflective of the Aboriginal students through a more representative sampling at the district, state and national levels.

The data collected in this study were based on students' self-rating on the questionnaire, and hence subjective in nature. While the validity and reliability of students' self-ratings are no longer a bone of contention (Meece, Anderman, & Anderman, 2006; Ramsden, 1997) and that the use of self-ratings has been widespread even among highly respected researchers who used self-ratings of students (Fraser, 1981; Hofstein & Lazarowitz, 1986; Kempa & Orion, 1989), a more balanced, comprehensive, and triangulated view is advocated by considering the views of teachers and parents.

REFERENCES

Adams, W.K., Perkins, K.K., Pololefsky, N.S., Dubson, M., Finkelstein, N.D., & Wieman, C.E. (2006). New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey (CLASS). *Physics Review Special Topics: Physics Education Research, 2*(1), 1-14.

Ahmad Nurulazam, M.Z., Mohd Ali, S., Rohandi, R. & Azman, J. (2010). Improving students' attitudes toward science using instructional congruence. *Journal of Science and Mathematics Education in Southeast Asia, 33*(1), 39-64.

Aziz, N., & Lin, H.L. (2011). Hubungan sikap terhadap mata pelajaran sains dengan penguasaan konsep asas sains pelajar tingkatan 2 (*The relationship between attitudes towards science and mastery of science concepts among form two students*). *Journal of Science & Mathematics Educational, 2, 89-101.*

Baldwin, J., Ebert-May, D., & Burns, D. (1999). The development of a college biology self efficacy instrument for non-majors. *Science Education, 83*(4), 397-408.

Becker, B.J. (1989). Gender and science achievement: A re-analysis of studies from two meta-analyses. *Journal of Research in Science Teaching, 26*(2), 141-169.

Blatchford, P. (1992). Children's attitudes to work at 11 years. *Educational Studies, 18,* 107–118.

Corell, S.J. (2004). Constraints into preferences: Gender, status, and emerging career aspirations. *American Sociological Review, 69*(1), 93-113.

Dalgety, J., Coll, R., & Jones, A. (2003). Development of Chemistry Attitudes and Experiences Questionnaire (CAEQ). *Journal of Research in Science Teaching, 40*(7), 649-668.

Field, A.P. (2005). *Discovering statistics using SPSS* (2nd ed.). London: Sage.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education* (8th ed.). NY: McGraw-Hill.

Francis, B. (2000) *Boys, girls and achievement: Addressing the classroom issues*. London: Routledge.

Fraser, B.J. (1981). Learning environment in curriculum evaluation: A review. *Evaluation in Education: An International Review Series, 5*(1), 3-93.

Gantreau, B., & Binns, I.C., (2008). Investigating student attitudes and achievements in an environmental place-based inquiry in secondary classrooms. *International Journal of Environmental & Science Education, 3*(3), 167-195.

Gardner, P.L. (1975). Attitudes to science: A review. *Studies in Science Education, 2*, 1-41.

George, R. (2000). Measuring change in students' attitudes towards science over time: An application of latent variable growth modeling. *Journal of Science Education and Technology, 9*(3), 213-225.

Germann, P.J. (1988). Development of the attitude toward science in school assessment and its use to investigate the relationship between science achievement and attitude toward science in school. *Journal of Research in Science Teaching, 25*(8), 689-703.

Gibson, H., & Chase, C. (2002). Longitudinal impact of an inquiry-based science program on middle school students' attitudes toward science. *Science Education, 86*, 693–705.

Gogolin, L., & Swartz, F. (1992). A quantitative and qualitative inquiry into the attitudes toward science of non-science college students. *Journal of Research in Science Teaching, 29*(5), 487-504.

Harvey, T.J., & Edwards, P. (1980). Children's expectations and realisation of science. *British Journal of Educational Psychology, 50*, 74-76.

Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so few? Women in science, technology, engineering and mathematics*. Washington, DC: AAUW.

Hofstein, A., & Lazarowitz, R. (1986). A comparison of the actual and preferred classroom learning environment in biology and chemistry as perceived by high school students. *Journal of Research in Science Teaching, 23*(3), 189-199.

Hutcheson, G., & Sofroniou, N. (1999). *The multivariate social scientist: Introductory statistics using generalized linear models*. Thousand Oaks, CA: Sage Publications.

Jarvis, T., & Pell. A. (2005). Factors Influencing Elementary School Children's Attitudes toward Science before, during, and after a Visit to the UK National Space Centre. *Journal of Research in Science Teaching, 42*(1), 53-83.

Jones, M. E., Gott, R., & Jarman, R. (2000). Investigations as part of the key stage 4 science curriculum in Northern Ireland. *Evaluation and Research in Education, 14*, 23–37.

Jovanovic, J., & King, S.S. (1998). Boys and girls in the performance-based science classroom: Who's doing the performing? *American Educational Research Journal, 35*(3), 477-496.

Kamisah, O. (2103). Exploration of Malaysian children's attitudes towards science and scientific attitudes. In Z. Azami, & V. Vodovozov (Eds.), *Recent Advances in Educational Technologies*. Paper presented at the 4th International Conference on Education and Educational Technologies (EET '13), Cambridge, MA (pp. 125-128). Cambridge: WSEAS Pres

Kamisah, O., Zanaton, I., & Lilia, H. (2007). Sikap terhadap sains dan sikap saintifik di kalangan pelajar sains. *Jurnal Pendidikan, 32*, 39-60.

Kempa, R.F., & Orion, N. (1996). Students' perception of co-operative learning in earth science fieldwork. *Research in Science and Technological Education, 14*(1), 33- 41.

Koballa, T.R., & Glynn, S.M. (2007). Attitudinal and motivational constructs in science learning. In S.K. Abell & N.G. Lederman (Eds.) *Handbook of research on science education* (pp. 75-102). Mahwah, NJ: Lawrence Erlbaum Associates.

Laugksch, C. R. (2000). Scientific literacy: A conceptual overview. *Science Education, 84*(1), 71 – 94.

Lightbody, P., & Durndell, A. (1996). Gendered career choice: Is sex-stereotyping the cause or the consequence. *Educational Studies*, 22, 133–146.

Lord, T., & Orkwiszewski, T. (2006). Moving from didactic to inquiry-based instruction in a science laboratory. *The American Biology Teacher*, *68*, 342–345.

Lowery, L.F. (1967). An experimental investigation into the attitudes of fifth grade students towards science. *School Science and Mathematics, 67*, 569-579.

Martin, M.O., Mullis, I.V.S., Foy, O., & Stanco, G.M. (2012). *TIMSS 2011 International Results in Science*. Chestnut Hill, MA: Lynch School of Education, Boston College.

Meece, J. L., Anderman, E. M., & Anderman, L. H. (2006). Classroom goal structure, student motivation, and academic achievements. *Annual Review of Psychology, 57*, 487–503.

Ministry of Education [KPM]. (2010). *Kurikulum Standard Sekolah Rendah (KSSR): Dunia Sains dan Teknologi Tahun 1*. Putrajaya: Bahagian Pengembangan Kurikulum

Nuttall, D. (1971). *Administrator's manual for Science Attitude Questionnaire*. Slough: NFER.

Ong, E.T., & Ruthven, K. (2009). The effectiveness of smart schooling on students' attitudes towards science. *Eurasia Journal of Science, Mathematics & Technology Education, 5*(1), 35-45.

Ormerod, M.B., Rutherford, M., & Wood, C. (1989). Relationships between attitudes to science and television viewing among pupils aged 10 to 13+. *Research in Science and Technological Education, 7*(1), 75- 84.

Osborne, J. F. and Collins, S. (2000). *Pupils' and parents' views of the school science curriculum.* London: King's College London.

Osborne, J., Driver, R., & Simon, S. (1997). *Attitudes to science: A review of research and proposals for studies to inform policy relating to uptake of science.* London: King's College.

Osborne, J., Driver, R., & Simon, S. (1998). Attitudes to science: Issues and concerns. *School Science Review, 79*(288), 27-33.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049-1079.

Papanastasiou, E., & Zembylas, M. (2002). The effect of attitudes on science achievement: A study conducted among high school pupils in Cyprus. *International Review of Education, 48*(6), 469-484.

Papanastasiou, E., & Zembylas, M. (2004). Differential effects of science attitudes and science achievement in Australia, Cyprus, and the USA. International Journal of Science Education, 26(3), 259-290.

Ramsden, J.M. (1998). Mission impossible? Can anything be done about attitudes to science? *International Journal of Science Education, 20*(2), 125-137.

Rennie, L.J., Goodrum, D., & Hackling, M. (2001). Science teaching and learning in Australian schools: Results of a national study. *Research in Science Education, 31*, 455–498.

Roberts, D.A. (2007). Scientific literacy/science literacy. In S.K. Abell & N.G. Lederman (Eds.), *Handbook of research on science education* (pp. 729-780). Mahwah, NJ: Lawrence Erlbaum Associates.

Schibeci, R.A. (1984). Attitudes to science: An update. *Studies in Science Education, 11*, 26-59.

Sesen, B.A., & Tarhan, L. (2013). Inquiry-based laboratory activities in electrochemistry: High school students' achievements and attitudes. *Research in Science Education, 43*, 413-435.

Simpson, R. D., & Oliver, J. S. (1990). A summary of major influences on attitude toward and achievement in science among adolescent students. *Science Education*, 74, 1–18.

Simpson, R., Koballa, Jr. T., Oliver, J., & Crawley, F. (1994). Research on the affective dimension of science learning. In D. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 211-234). New York: MacMillan Publishing Company.

The Royal Society. (2006). *Increasing uptake of science post-16*. London: The Royal Society.

Turpin, T.J. (2000). *A study of the effects of an integrated, activity-based science curriculum on student achievement, science process skills, and science attitudes*. Unpublished EdD dissertation, University of Louisiana at Monroe, USA.

Twenty First Century Science (undated). *Scientific literacy*. Accessed on June 18, 2013, from http://www.nuffieldfoundation.org/twenty-first-century-science/scientific-literacy

Wandersee, J., Mintzes, J., & Novak, J. (1994). Research on alternative conceptions in science. In D. Gabel (Ed.), *Handbook of Research on Science Teaching and Learning* (pp. 177-210). New York: MacMillan Publishing Company.

Warrington, M., Younger, M. & Williams, J. (2000) Student attitudes, image and the gender gap. *British Educational Research Journal*, 26(3), 393–407.

Weinburgh, M.H. (1995). Gender differences in student attitudes toward science: A meta-analysis of the literature from 1970-1991. *Journal of Research in Science Teaching, 32*(4), 387-398.

Weinburgh, M.H. (2000). Gender, ethnicity, and grade level as predictors of middle school students' attitudes towards science. *Current Issues in Middle Level Education*, *6*(1), 87-94.

Wellington, J. (1990). Formal and informal learning in science. The role of the interactive science centres. *Physics Education, 25*, 247–252.

Whitelaw, S., Milosevic, L., & Daniels, S. (2000) Gender, behaviour and achievement: A preliminary study of pupil perceptions and attitudes. *Gender and Education*, 12(1), 87–113.

Wideen, M.F. (1975). Comparison of student outcomes for science – a process approach and traditional science teaching for third, fourth, fifth, and sixth grade classes: A product evaluation. *Journal of Research in Science Teaching*, *12*(1), 31-39.

Woolnough, B.E. (1990). *Making choices*. Oxford, UK: Oxford University Department of Educational Studies.

Yager, R.E., & Penick, J.E. (1986). Perceptions of four age groups toward science classes, teachers, and the value of science. *Science Education*, *70*(4), 355-363.

Zanaton, I., Lilia, H., & Kamisah, O. (2006). Sikap terhadap sains dalam kalangan pelajar sains peringkat menengah dan matrikulasi. *Pertanika Journal of Social Sciences & Humanities*, *14*(2), 131-147.