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The Interaction Effects of Gender and Grade Level on Secondary School Students' Attitude towards Learning Chemistry

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This quantitative study reports the effects of gender and grade level on secondary students' attitude towards chemistry lessons. For this purpose, the Attitude towards Chemistry Lessons Scale (ATCLS) was administered to 446 secondary school students between 16-19 years old. The ATCLS consists of four different subscales: liking for chemistry theory lessons, liking for chemistry laboratory work, evaluative beliefs about school chemistry and behavioral tendencies to learn chemistry. Data obtained from the ATCLS survey was analyzed using two-way MANOVA to identify the effects of gender and grade level on students' attitude towards learning chemistry. The findings show that gender and grade level have a significant effect on attitude towards learning chemistry. Gender and grade level also have a significant interaction effect (Wilks' lambda = 0.933, $F(15, 1198) = 2.032$, $p < 0.05$) on secondary school students' attitudes towards chemistry.

Keywords: Attitude, Gender, Grade Level, Learning Chemistry.

INTRODUCTION

Chemistry is a discipline that studies the chemical and physical properties, behaviors and the composition of matter at structural, macroscopic and submicroscopic levels. Since knowledge of chemistry is essential for students to learn other subjects such as biology, physics, geology, environmental science, and ecology, chemistry is generally known as the "central science" or "Mother of all Sciences" (Ahiakwo, 2002; Goldsby & Raymond, 2013; Jimoh, 2005). Chemistry also has close connection with our daily routines. The air we breathe, the food we eat, the water we drink, and the fuel we use for transportation and cooking are some of the examples that involve chemistry in our daily life. Innovations and developments of today's chemistry will contribute to the development of many areas for example, manufacturing, telecommunications, and medical, to name a few. Therefore, it is important for our students to have a positive attitude towards learning chemistry to ensure they are able to adapt with the changes in their daily life and at the same time contribute to the development of science and technology of the country in a sustainable manner (Curriculum Development Center, 2006). In fact developing positive attitudes was perceived as one of the key goals for teaching and learning chemistry at secondary level (Hofstein & Naaman, 2011).

Attitude is one of the popular hypothetical construct applied by researchers to explain phenomena of one's interest, the way people think, how they feel and how they carry out things (Fazio & Olson, 2007; Shcwarz, 2007). Attitude was defined as a characteristic for a human to express their feeling of like or unlike of an object, person or an event (Ajzen, 2005). Studies indicate that attitude is the predictor of human behavior (Eagly and Chaiken, 1995) and future preference (Glasman & Albarracin, 2006). Specifically, in the context of science education when the student favors

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State of the literature

- A positive attitude towards learning chemistry will contribute towards the high achievement in the subject.
- Gender and grade level are factors that influence students' attitude towards learning chemistry.
- Although many studies have investigated attitude towards learning chemistry in the area of gender and grade level, there are limited studies focusing on the interaction effects between grade level and gender.

Contribution of this paper to the literature

- Lack of studies that specifically examine secondary school students' attitude towards learning chemistry across the grade level from form 4 till upper 6 and the interaction effects between grade levels with gender.
- Addresses the issue of low enrolment in science related subjects.
- Interaction effects occur between gender and grade level in students' attitude towards learning chemistry.
- Students have a more positive attitude towards learning chemistry when they reach public examination year.

certain science subject this in turn is a good predictor of students' choice of the subject (Kelly, 1988).

In science education, apart from academic achievement, attitude of the students is considered as another important aspect to be emphasized in academic evaluation (Bennett, Lubben, & Hogarth, 2007). A positive attitude toward school science will contribute to high achievement in the science subjects. Lack of interest in learning science due to low attitude towards learning science was perceived as one possible reason for the students to perform below average in TIMSS and PISA assessments (Osborne et al., 2003). Therefore, it is crucial for school teachers to evaluate students' attitude towards learning of science lessons. Attitude is not a permanent process or action and it is not resistant to change (Xu, Villafane, & Lewis, 2013). This indicates that students' attitude will change through their direct or indirect learning, observation, experiences and the learning environment. Additionally, factors such as gender (Barnes, McInerney, & Marsh, 2005; Can, 2012; Cheung, 2009b; Dhindsa & Chung, 1999; Hofstein, Ben-Zvi, Samuel, & Tamir, 1977; Salta & Tzougraki, 2004) and grade level have also been reported to influence attitude (Can, 2012; Can & Boz, 2012; Cheung, 2009b; Hofstein et al., 1977). Hence, in this study an attempt has been made to evaluate the effect of gender and grades on Malaysian secondary school students' attitude towards learning chemistry.

The outcome of this study will be beneficial in helping teachers and curriculum developers to address the issues of low enrollment in science related subjects among these groups of students. The government has projected to produce 72 research scientists and engineers per 10,000 workers as one of the criteria to be among the developed nations of the world by 2020 (Day & Muhammad, 2011, p. 38; New Straits Times, 2013; Sin Chew Daily, 2013). However, critically low enrollment in science related subjects (lower than 20%) has adversely impacted the nation's aspiration of achieving the status of a fully developed country by the year 2020 (Chew, Idris, Leong, & Daud, 2013; Ministry of Science Technology and Innovation, 2012; Perimbanayagam & Duzlkafli, 2012).

Background

Based on the type of responses, previous studies have classified attitude into three categories: cognition, affect and conation. Cognitive responses refer to the person's belief and perception; affective to the evaluation and the feeling and conation refers to the behaviours towards the subject matters (Ajzen, 2005; Hilgard, 1980; Huitt & Cain, 2005). From this perspective, the three components of attitude were presented as separate entities in an isolate manner. Therefore, it was suggested that viewing attitude as cognitive, affective and conation dimensions does not reflects the whole concept of attitude (Oskamp & Schultz, 2005).

On the contrary in the most recent studies, in more holistic manner, attitude was viewed as a latent process that explains the relationship between the stimulus and the responds to the stimulus which is the human behaviour. Figure 1 illustrates attitude as latent process. This view about attitude was generally accepted by the recent attitude researches such as Eagly and Chaiken (2005); Oskamp and Schultz (2005). Hence, for the purpose of this study this view was adapted to measure the secondary school students' attitudes towards the learning chemistry lessons. In the context of this study, attitude is referring to the students' favourable or unfavourable towards the chemistry lessons which were presented in four dimensions: liking for chemistry theory lessons; liking for chemistry lab work; evaluative beliefs about school chemistry and behavioural tendencies to learn chemistry.

Previous studies confirm that there is correlation between attitudes and academic performance (Cheung, 2011; Linn, 1992; Neathery, 1997; Osborne & Collins, 2000; Otor & Achor, 2013). Various researches have investigated students' attitude towards learning science and their science achievement (Freedman, 1997; Salta &

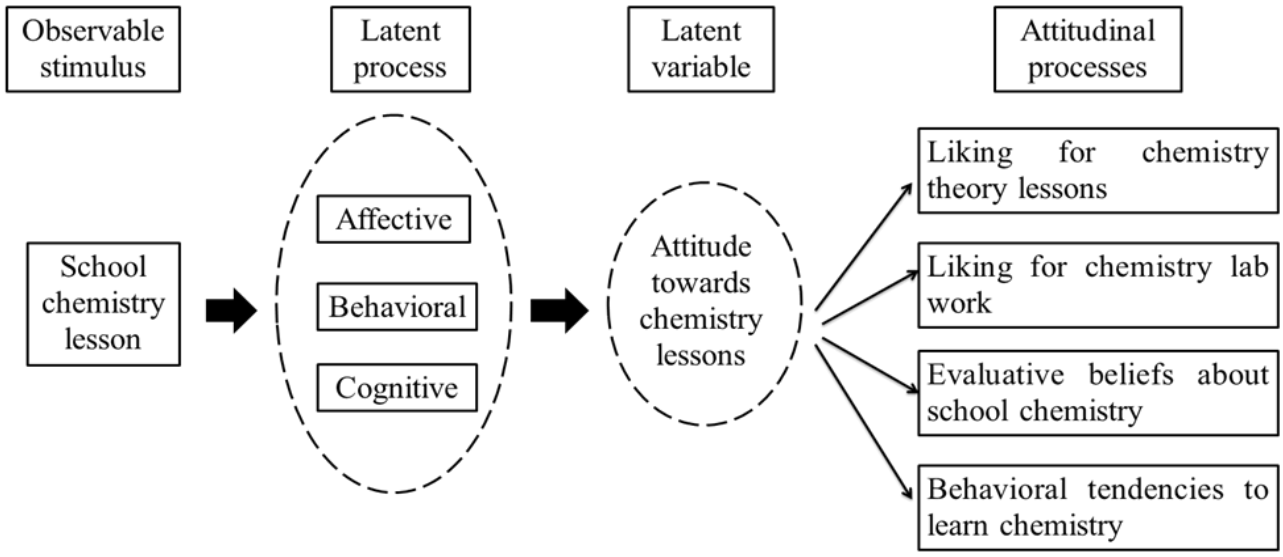

Figure 1. Latent process viewpoint adopted from Cheung (2009a)

Tzougraki, 2004). In a study involving 576 11th grade (16–17 years old) high school students, Salta and Tzougraki (2004) reported that there is a positive significant correlation between students' attitude towards chemistry and their achievement in chemistry in high schools in Greece. Besides, there is extensive evidence for the existence of a positive relationship between achievement and attitude among secondary, college and undergraduate students (Bennett et al., 2001; Cheung, 2009b; Cukrowska, Staskun, & Schoeman, 1999; House, 1995).

Research conducted by Osborne and Collins (2000) involving high school students, has found that chemistry is the most unfavorable subject among all the school science subjects and these students also possess a negative attitude towards learning chemistry. Additionally, Bennett et al. (2001) in their study found out that generally South African University undergraduate students have less positive attitude towards chemistry and obtained lower scores in chemistry tests.

Research conducted by Hofstein et al. (1977) with secondary school students has shown that there was a significant difference between girls' and boys' attitude towards learning chemistry. In general, girls tend to have more positive attitude towards learning chemistry compared to their male counterparts (Hofstein et al., 1977). In Hong Kong in a study involving students across secondary 4 – 7, it has been reported that male students have marginally positive attitude towards chemistry (Cheung, 2009b). Dhindsa & Chung (1999) also noticed a similar phenomenon among Brunei Form 5 students and reported that girls enjoyed their chemistry classes more than boys. Other researchers such as Shannon, Sleet, and Stern (1982) and Steinkamp and Maehr (1984) also claimed that females' attitude towards school chemistry were more positive than males in different countries and settings. In Kenya, Majere, Role, and Makewa (2012) have reported that females have more positive attitude towards chemistry than males. At the same time they also reported that male students' self-concept in chemistry and perceptions of the usefulness of chemistry is relatively lower than their female peers. On the contrary, in other studies, boys were perceived to have more positive attitude towards learning chemistry than girls (Barnes et al., 2005; Harvey & Stables, 1986; Menis, 1983). In addition, a survey involving grade 10 students in Israel claimed that boys had more positive attitude towards learning chemistry compared to girls.

In addition to gender, grade is another important variable that significantly influences development of attitude among chemistry students. In Turkey, Can and Boz (2012) reported that high school students' attitude towards learning chemistry decreased significantly with increase in grade level. Specifically, in this study involving Grade 9 – 11 students, it was identified that female students' attitudes towards secondary school chemistry were more positive compared to male students and at the same time there was an interaction effect between gender and grade level. In Australia, a survey involving 449 year 10 students from five different high schools in Sydney indicated that male students are more interested in learning chemistry (Barnes et al. 2005). In another quantitative study involving 2,311 third year secondary school students in England, male students were found to have more positive attitude towards chemistry than other subjects such as biology, physics and general science (Harvey & Stables, 1986). The interaction effect between gender and grade level on attitude towards learning chemistry was also identified among 954 chemistry students in Hong Kong (Cheung, 2009b). This study reported that boys liked chemistry theory lessons more than girls

Table 1. Distribution of students by gender and grade level (N = 446)

Gender	Male	:	191 (42.8%)
	Female	:	255 (57.2%)
Grade level	Form 4	:	154
	Form 5	:	166
	Lower 6	:	69
	Upper 6		57

Table 2. Attitudes towards chemistry lessons scale

Dimensions and items		
Liking for chemistry theory lessons:		
Q1	:	I like chemistry more than any other school subject
Q2	:	Chemistry lessons are interesting
Q4	:	Chemistry is one of my favorite subjects
Liking for chemistry laboratory work:		
Q6	:	I like to do chemistry experiments
Q7	:	When I am working in the chemistry lab, I feel I am doing something important
Q10	:	Doing chemistry experiments in school is fun
Evaluative beliefs about school chemistry:		
Q3	:	Chemistry is useful for solving everyday problems
Q8	:	People must understand chemistry because it affects their lives
Q11	:	Chemistry is one of the most important subjects for people to study
Behavioral tendencies to learn chemistry:		
Q5	:	I am willing to spend more time reading chemistry books
Q9	:	I like trying to solve new problems in chemistry
Q12	:	If I had a chance, I would do a project in chemistry

especially in secondary 4 and secondary 5, while male students' liking for laboratory work decreased from secondary 4 to secondary 7 (Cheung, 2009b).

Purpose of the study

Previous studies on secondary school students' attitude towards learning chemistry produced inconsistent results (Cheung, 2009). Hofstein et al., (1977) stated that attitude towards learning chemistry decline when the students' progress from grade 11 to 12. On the other hand according to Menis (1983) grade 12 students' attitude towards learning chemistry is higher than grade 11. Cheung (2009) suggested that one possible reason for the inconsistency could be that in the aforementioned studies gender and its interaction effect with grade was not measured. Following Cheung's suggestions, purpose of this study was to measure the interaction effect of gender and grade level on secondary school students' attitude towards learning chemistry from Malaysian perspective.

RESEARCH METHODOLOGY

Sampling of the study

In Malaysia, secondary schooling consists of 7 years, involving 5 years of compulsory schooling (Forms 1-5) and 2 years of pre-university (Lower 6 and Upper 6). Chemistry is offered as an elective subject to secondary 4 and 5 science stream students and chemistry is a compulsory subject for pre-university science stream students. For the purpose of this study, 446 students (191 males and 225 females) from seven schools in the district of Perak were involved. These students were randomly selected from seven different schools. Table 1 provides the details of the samples involved in this study according to gender and grade level.

Instrument: Questionnaire on the Attitude towards Chemistry Lessons (ATCLS)

A modified version of the Attitude Towards Chemistry Lessons Scale (ATCLS) developed by Cheung (2009a) was used in this study. The ATCLS uses a four point Likert-type scale ranging from Strongly Disagree (1), Disagree (2), Agree (3) and Strongly Agree (4) to evaluate students' attitude towards learning chemistry. The questionnaire consisted of 12 items and four subscales: liking for chemistry theory lessons, liking for chemistry laboratory work, evaluative beliefs about school chemistry and behavioral tendencies to learn chemistry. Each subscales consisted of 3 items. Table 2 provides details of the ATCLS. The scale was administered in two different studies in Hong Kong and all the four subscales possessed Cronbach's alpha values between 0.76 to 0.86 (Cheung, 2009b; 2011). In another study conducted in Turkey, Senocak (2011) adopted the

ATCLS questionnaire and reported that all the four subscales possessed relatively high internal consistency and reliability (0.68 to 0.84). Due to its relatively high internal consistency it was decided to use the ATCLS in this study.

Procedure for data analysis

The responses of students to the ATCLS items were coded based on the scales of 1 (strongly disagree) to 4 (strongly agree). The higher the score shows that respondents possess more positive attitude towards learning chemistry. In the questionnaire, the neutral scale was eliminated. The main reason for not providing the neutral middle choice is to force the respondents to decide whether they agree or disagree with the statements. In some instances students choose the neutral option scale as they feel reluctant to express their own opinions, and this can have a significant impact on the results (Ma, 1998). The data collected were analyzed using a SPSS statistics program. A two-way multivariate analysis of variances (MANOVA) was used to determine the effects of gender and grade on all the four subscales in the ATCLS. Further in depth analysis was carried out in the cases where the interaction effects were significant.

RESULTS

Prior to the actual study, a pilot study was conducted to identify the reliability of the instrument. The Cronbach's alpha value was computed for each dimension and for the whole scale. The alpha values obtained ranged from 0.71 to 0.84 for the four subscales (Liking for chemistry theory lesson = 0.84; Liking for chemistry laboratory work = 0.75; Evaluative beliefs about school chemistry = 0.71; Behavioral tendencies to learn chemistry = 0.72) and 0.88 for the overall scale. Despite the values obtained from the pilot study being lower than the ones reported in the literature (Cheung, 2009b; 2011), these values are still in the acceptable range (Nunnally, 1978).

The results of the two-way MANOVA showed that gender (Wilks' lambda = 0.956, F (5, 434) = 3.976, $p < 0.005$) and grade level (Wilks' lambda = 0.830, F (15, 1198) = 5.582, $p < 0.001$) have a significant effect on attitude towards learning chemistry. Gender and grade level also have a significant interaction effect (Wilks' lambda = 0.933, F (15, 1198) = 2.032, $p < 0.05$) on secondary school students' attitudes towards chemistry. Since, the interaction effect appears to be significant further analysis was performed to ascertain which subscales of the ATCLS exhibit significant interactions. All the four subscales exhibited significant interaction effects between gender and grade level (liking for chemistry theory lesson F (3, 438) = 4.531, $p < 0.05$; liking for chemistry laboratory work F (3, 438) = 4.513, $p < 0.05$; evaluative beliefs about school chemistry F (3, 438) = 7.189, $p < .05$; behavioral tendencies to learn chemistry F (3, 438) = 3.094, $p < 0.05$); towards attitude in learning chemistry.

Since significant interaction effects were noticed in the four subscales further analysis was performed to identify whether the results favored the male or female students and in which grade levels. The two-way MANOVA results indicated that gender is statistically significant on the liking for chemistry theory lessons subscale ($Mean_{male} = 2.80$, $Mean_{female} = 3.01$; $p < .05$); liking for chemistry laboratory work ($Mean_{male} = 3.11$, $Mean_{female} = 3.32$; $p < .05$); evaluative beliefs about school chemistry ($Mean_{male} = 3.07$, $Mean_{female} = 3.33$; $p < .05$); and behavioral tendencies to learn chemistry ($Mean_{male} = 2.85$, $Mean_{female} = 3.02$; $p < .05$). In general, female students have more positive attitude towards the school chemistry lessons. This can be observed in all four dimensions where all the mean scores for female students are higher compared to their male counterparts.

Two-way MANOVA results also show that grade level is statistically significant to all four dimensions; liking for chemistry theory lesson ($Mean_{maleF4} = 2.35$, $Mean_{femaleF4} = 2.78$; $Mean_{maleF5} = 3.17$, $Mean_{femaleF5} = 3.07$; $Mean_{maleL6} = 2.93$, $Mean_{femaleL6} = 3.15$; $Mean_{maleU6} = 3.03$, $Mean_{femaleU6} = 3.17$; $p < .05$); liking for chemistry laboratory work ($Mean_{maleF4} = 2.86$, $Mean_{femaleF4} = 3.27$; $Mean_{maleF5} = 3.38$, $Mean_{femaleF5} = 3.35$; $Mean_{maleL6} = 3.22$, $Mean_{femaleL6} = 3.29$; $Mean_{maleU6} = 2.67$, $Mean_{femaleU6} = 3.38$; $p < .05$); evaluative beliefs about school chemistry ($Mean_{maleF4} = 2.85$, $Mean_{femaleF4} = 3.32$; $Mean_{maleF5} = 3.35$, $Mean_{femaleF5} = 3.27$; $Mean_{maleL6} = 2.95$, $Mean_{femaleL6} = 3.27$; $Mean_{maleU6} = 3.06$, $Mean_{femaleU6} = 3.32$; $p < .05$) and behavioral tendencies to learn chemistry ($Mean_{maleF4} = 2.57$, $Mean_{femaleF4} = 2.90$; $Mean_{maleF5} = 3.13$, $Mean_{femaleF5} = 3.05$; $Mean_{maleL6} = 2.86$, $Mean_{femaleL6} = 3.04$; $Mean_{maleU6} = 2.94$, $Mean_{femaleU6} = 3.18$; $p < .05$).

Since there was a significant result in the four dimensions on grade level, a post hoc Bonferroni test was conducted to identify which grade levels had significant effects among the four dimensions. Post hoc test results showed that the subscale, liking for chemistry lessons, had a significant effect between form 4, form 5, lower 6 and upper 6. Meanwhile, liking chemistry laboratory work and evaluative beliefs about school chemistry subscales only showed significant effects between form 4 and form 5. However the behavioral tendencies to learn chemistry subscale only reflected significant effects between form 4, form 5 and upper 6 students.

Table 3. Post hoc tests (Bonferroni) across grade level

Dimension	(I) Grade level	(J) Grade level	Sig.
Liking for chemistry theory lessons	Form 4	Form 5	0.00
		Lower 6	0.00
		Upper 6	0.00
	Form 5	Form 4	0.00
		Lower 6	1.00
		Upper 6	1.00
	Lower 6	Form 4	0.00
		Form 5	1.00
		Upper 6	1.00
	Upper 6	Form 4	0.00
		Form 5	1.00
		Lower 6	1.00
Liking for chemistry laboratory work	Form 4	Form 5	0.00
		Lower 6	0.15
		Upper 6	0.66
	Form 5	Form 4	0.00
		Lower 6	1.00
		Upper 6	0.74
	Lower 6	Form 4	0.15
		Form 5	1.00
		Upper 6	1.00
	Upper 6	Form 4	0.66
		Form 5	0.74
		Lower 6	1.00
Evaluative beliefs about school chemistry	Form 4	Form 5	0.01
		Lower 6	1.00
		Upper 6	0.84
	Form 5	Form 4	0.01
		Lower 6	0.26
		Upper 6	1.00
	Lower 6	Form 4	1.00
		Form 5	0.26
		Upper 6	1.00
	Upper 6	Form 4	0.84
		Form 5	1.00
		Lower 6	1.00
Behavioral tendencies to learn chemistry	Form 4	Form 5	0.00
		Lower 6	0.05
		Upper 6	0.00
	Form 5	Form 4	0.00
		Lower 6	1.00
		Upper 6	1.00
	Lower 6	Form 4	0.05
		Form 5	1.00
		Upper 6	1.00
	Upper 6	Form 4	0.00
		Form 5	1.00
		Lower 6	1.00

DISCUSSIONS

From the previous research it is evident that attitude is one of the affective component that significantly influences students' learning. Following this claim, various attempts have been made with the intention to improve students' attitude towards specific subject matter. For instance, Abdullah et al., (2014) employed thinking and visual presentation approach to improve students' attitude towards mathematics. Additionally, Escalera-Chavez et al., (2014) proposed a model on students' attitude towards learning statistic with aim that this model will be used by the statistic teachers or educators to improve the learning of statistics. Similarly, attempt has been made in this study to evaluate the factors influences students' attitude toward chemistry lessons. Specifically, this study was aimed to investigate

the existence of interaction effects between gender and grade level on secondary school students' attitude towards chemistry lessons. Based on the outcome of two-way MANOVA and post hoc Bonferroni test, it could be surmised that significant differences were noticed among the four grade levels for the subscale, liking for chemistry theory lessons. Female students from all the grade levels exhibited higher mean scores for the subscale liking chemistry theory lessons except female students in the form 5 classes; an increasing trend was noticed in the mean score for this subscale with the grade level. On the contrary, male students exhibited higher liking towards theory lessons in lower grades and the liking tended to decrease in the higher grades. These findings appear to contradict other previously reported studies (Barnes et al., 2005; Cheung, 2009b; Harvey & Stables, 1986). Although females started with liking chemistry theory lessons more than the male counterparts, however their attitude just remained marginally positive across grades from form 4 to upper 6 with the mean score ranging between 2.78 and 3.17. The majority of the male students in form 4 tended to be less interested in chemistry theory lessons (mean score = 2.35), however interest increased in form 5 and remained marginally positive until upper 6 (mean score varied between 2.93 and 3.17).

For the subscale liking chemistry laboratory work, the interest of male students in laboratory work increased from form 4 (2.86) to form 5 (3.38) and decline in lower 6 (3.22) and upper 6 (2.67). Although interest in laboratory work decreased, in general male students' interest still remained marginally positive in form 4 and upper 6 and slightly positive in form 5 and lower 6 (mean score varied between 2.86 and 3.37). Meanwhile, female students' attitudes to chemistry lessons expressed by their liking for chemistry laboratory work remained slightly positive from form 4 to upper 6 (mean score varied between 3.27 and 3.38). They showed an increase in the liking for chemistry laboratory work in form 5 and upper 6. Attitudes to chemistry lessons expressed by their liking for chemistry laboratory work shows a significant difference between the genders with the attitude of females appearing to be more favorable to chemistry laboratory work (mean score 3.32) as compared to their male counterparts (mean score 3.11). This finding is quiet similar to that of Dhindsa and Chung's (1999) study that focused on form 5 students in Brunei which concluded that females were more in favour of chemistry laboratory work compared to the males.

For the evaluative beliefs subscale, male students showed fluctuations in the mean score and there was a significant difference between both sexes and form 4 and form 5 students. However, females showed more stable and slightly positive attitude towards chemistry from the perspective of evaluative beliefs (mean score varied between 3.27 and 3.33). Meanwhile for the behavioral tendencies subscale, both males and females experienced marginally positive attitudes with the attitude of females (mean score 3.02) being slightly higher than their male counterparts (mean score 2.85). This finding is not consistent with the findings of Cheung (2009b) and Dhindsa and Chung (1999). In Brunei, when examining students' tendencies to learn more about chemistry and the importance of chemistry, there was no significant difference between the sexes (Dhindsa & Chung, 1999). Similar results were also reported by Cheung (2009b) in Hong Kong where there were no significantly different changes in attitude across the grade levels and gender for both evaluative beliefs and behavioral tendencies. In Turkey, generally both the female and male students perceived chemistry as important and no significant differences were reported between the female and male students' views about the importance of chemistry. However, grade 9 and 10 students specifically perceived the importance of chemistry differently with grade 9 students having a higher mean score than grade 10 students for this subscale (Can, 2012).

The quality of teaching science is a significant factor that will determine students' attitude towards science subjects in schools (Osborne, Simon & Collins, 2003; Papanastasiou & Papanastasiou, 2004). A cross national meta-analysis based on TIMSS data has shown that teaching strategies have a direct effect on students' attitude towards science (Papanastasiou & Papanastasiou, 2004). From the data obtained, it clearly showed that male students had lower mean scores in all the four subscales compared to their female counterparts. Therefore, different attention and approaches may be needed to help them to develop a more positive attitude towards chemistry lessons. For male students, it is important to note that the attitude started lower compared to their female peers for all the four dimensions and the difference was statistically significant. There was a gap between male and female students' attitude in learning chemistry at the early stage of learning. This outcome suggests that chemistry teachers should consider the existence of the gap in attitude between male and female students prior to deciding on the teaching strategies.

Male students liking for chemistry laboratory work kept decreasing after form 5. This is probably due to the nature of experiments presented in the textbook. The experiments needed the students to follow the procedures in a cookbook style of doing work. Students do not have the opportunities to explore themselves. Additionally, the experiments provided in the textbook might not be relevant to the male students' everyday lives. Students of 21st century expect a more challenging nature of learning rather than following fixed procedures provided in the textbooks. For instance male

students reported to enjoy inquiry-based laboratory compared to female students (Wolf & Fraser, 2008).

In general, female students felt that chemistry is more interesting and important. Similarly, Frazer and Shotts (1987) also reported that female students perceived that learning chemistry is important for their daily life. These results suggest that chemistry teachers need to consider the gender effect in determining the type of strategies that they use to teach chemistry concepts. Teachers should be alert to the differences and tailor appropriate teaching materials, approaches and pedagogical skills within the gender framework. Textbooks and other curriculum materials may need to be critically evaluated, as these may place more emphasis on male related issues that will spark their interest to learn more about chemistry. At the same time, chemistry learning should be able to connect real world situations with the content. This not only will motivate students to learn chemistry in school, but at the same time it will develop students' ability to handle and solve problems in real world situations based on the knowledge and skills that they learn in school (Cheung, 2009b).

A peak can be observed in the majority of the subscales between form 5 and upper 6 among male and female students. Their attitudes suddenly increased from form 4 to form 5 and reached a peak at form 5. However this situation did not remain but declined among students in lower 6 and increased again with students in upper 6. This phenomenon is contrary to expectations. Many previous studies (Can, 2012; George, 2006) have claimed that students' attitude towards science lessons decreased with the increase of grade level from junior high school to senior high school. Surprisingly this situation seems to be contradictory in this study. Probably, this is due to the fact that at the end of form 5 and upper 6 students are required to sit for public examinations. Major examinations have an impact on students' attitude because the results finally determine their further study in tertiary institutions. After the form 5 public examinations, students will either further their studies in private universities or colleges or continue their study to form 6. Therefore, students invest substantial time and effort in obtaining good grades. Furthermore, students' achievement in the major examination also finally determines the possibility of securing financial assistance for their future studies at tertiary level.

However, further study is needed to explore why the male students' attitude appears to be lower in all the four subscales and detailed insights are also needed to explain the reason for the attitude peaking in form 5 and then declining during form 6. Additionally, it is suggested that research be conducted involving students from different states in Malaysia so that the outcome could be generalized.

CONCLUSION

The main purpose of this study was to investigate the interaction effects between gender and grade level on secondary school students' attitude towards chemistry learning. In this study, students' attitudes were measured with a multidimensional questionnaire that covers students' liking for chemistry theory lessons, liking for chemistry laboratory work, behavioral tendencies to learn chemistry and evaluative beliefs about school chemistry. This study provides a clear picture on the variation of male and female students' attitude towards chemistry lessons associated with grade levels. The interaction effects between gender and grade level was determined by two-way MANOVA to avoid any type I error; this procedure is more trustworthy compared to other simple inferential statistical analyses. This study provided more holistic evidence not only in comparing the attitude towards chemistry lessons among male and female students but also provided substantial information about how attitude towards learning chemistry of both the female and male students changed across grade level from form 4 to upper 6. This information will be useful for chemistry teachers in considering the differences among their students.

In this study, it was found that female students have more positive attitude towards chemistry lessons compared to male students. Besides this, male and female students' attitude did not decrease as reported in some other researches (e.g. Can, 2012; George, 2006) when they moved from junior high school to senior high school. The results show that when students move from a non-public examination year to a public examination year, their attitude towards chemistry lessons in all four dimensions increases. This outcome needs further exploration.

At the same time, the results also show that overall male and female students' attitude towards learning chemistry in the four dimensions is marginally positive in the range 2.35 to 3.38 based on scale of 1 to 4. This reflects that the nation's objectives of developing positive attitudes towards chemistry are unlikely to be attained as desired. More aggressive steps and improvements should be taken to achieve this goal. A negative attitude towards chemistry may hinder Malaysia's move forward to becoming a technologically-developed country and achieving the Vision 2020. The outcome of this study suggests that school chemistry lessons should take gender difference into account and make the teaching and learning more male-friendly in order to improve male students' attitude towards learning chemistry beginning from an early stage.

Although this study shows that male students' attitude toward chemistry lessons is less positive compared to their female counterparts, generalizations cannot be made about the whole population as this

result is based on a cross-sectional data and the sample is too small to make generalizations for the whole population (Cheung, 2009b; Chew et al., 2013). Therefore a longitudinal study that follows the same students over four years to study changes in their attitude toward learning chemistry is recommended. Further research is needed to ascertain the reason behind the gender differences across the grade levels in students' attitude towards chemistry lessons.

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