

Level of Chemophobia and Relationship with Attitude towards Chemistry among Science Students

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Abstract. - This study was conducted to investigate the level of chemophobia among science students and their attitude towards chemistry and their relationship. 101 Form 4 and Form 5 respondents were involved. Instrument used in this study was questionnaires comprises of three sections namely demographic background, level of chemophobia (chemistry learning anxiety, chemistry evaluation anxiety and chemicals handling anxiety) and attitude towards chemistry (enjoyment of learning chemistry, enjoyment of conducting laboratory activities, importance of chemistry in life and behavioral tendency to learn chemistry). Research findings showed that chemophobia among science students was at moderate level whereas students' attitude towards chemistry was at high level. Research findings also showed that there was a moderate, negative significant relationship between the three factors of chemophobia with students' attitude towards chemistry. Based on multiple regression analysis, there was a factor in chemophobia (chemistry evaluation anxiety) that showed significant influence with students' attitude towards chemistry. This study implied that chemophobia among students should be overcome so that positive attitude towards chemistry could be instilled and hence, this would lead to the improvement in academic achievement and student's participation in chemistry and science-related field.

Keywords: *Chemophobia, Attitudes, Chemistry, Anxiety, Laboratory activities, Science stream.*

1. Introduction

Science is one of the important branches of knowledge. According to Human Capital Direction of Science and Technology Plan, science is identified as one of the areas to be mastered in order to improve the quality of life and develop the country's economy. In accordance with this, the government through the Ministry of Education Malaysia (MOE) has drafted '60:40 Policy' which is 60 percent of students participating in scientific / technical stream and 40 percent of students joining the arts stream. This policy establishes more student participation in the science stream to ensure that impeccable human capital in science can be produced.

However, the disclosure that only 29 per cent of students joined the science stream at public schools and universities has made it clear that we are still far away from reaching the 60:40 Policy target (Fatin, Mohd Salleh, & Mohammad Bilal, 2012). This may affect the goal of the Human Capital Direction of Science and Technology Plan and the achievement of a developed nation status by the year 2020. According to Fatin et al. (2012), in addition to the deterioration of students' participation in science stream, the achievement of Malaysian students in international assessments such as the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA) has also decreased.

Malaysia's participation in TIMSS in 2009 showed a decline in terms of ranking compared other countries in this region. What is more worrisome is 38% of Malaysian students failed to achieve the minimum skills for Science subjects (Kementerian Pendidikan Malaysia, 2013). The PISA results in 2009 was also not encouraging as Malaysia's position was in the bottom third of 74 countries (Kementerian Pendidikan Malaysia, 2013). The drop in students' participation and achievement in science subjects should be taken seriously as this scenario can inhibit Malaysia's goal to become a developed nation by 2020.

There are several factors identified as the cause of the drop in participation in science stream and the decreased science achievement, especially in TIMSS and PISA. One of them is the negative attitudes towards science subjects. The study conducted by Zanaton, Lilia and Kamisah (2006) found that students showed negative attitude towards science and they considered the subject as boring and the content is too abstract. Aziz and Lin (2011) found that students had a negative attitude towards Science because they considered the concepts are too difficult to learn. This negative attitude may ultimately lead to the misconceptions of an abstract science concept (Fatin et al., 2012)

As a result, fewer students joined the elective science subjects such as chemistry, biology, physics and additional science because of the negative attitudes of students towards the subject. Among the elective science subjects offered, chemistry is believed to be one of the most difficult subjects and students tend to have a negative attitude towards chemistry (Md Nor & Tay, 2010). Edaya (2012) found that students considered the chemistry curriculum to be too complex and difficult to learn and this led to the drop in student participation in the science stream.

Nuraffandy and Fatimah (2012) argued that students regard chemistry as a subject that is difficult to master because it does not only involve scientific concepts, but also involves mathematical skills such as balancing the chemical equation. Students are also failed to relate the knowledge in

chemistry to everyday life (Edaya, 2012). Therefore, the negative attitudes of students towards chemistry should be overcome because chemistry is closely related to daily life and is one of the branches of knowledge that students must master in order to progress in science alongside other developed countries.

In addition, anxiety factor or chemophobia (concern about chemistry) is also a contributing factor to the marginalization of science subjects especially chemistry among students. According to Edaya (2012), students' attitude and appreciation of chemistry is high but their confidence in chemistry is low. Chemophobia disturbs learning process in the sense that students are unable to optimally absorb the knowledge because of the mental barrier. They are unwilling to change their negative perception about chemistry. Chemophobia is also the cause of the low number of students taking chemistry subjects.

Fatin et al. (2012) also found that lower levels of academic confidence as well as concerns about learning difficulties are identified as one of the factors that cause many students to refuse to choose science stream. The study conducted by Adeline and Lay (2014) also found that students with high chemophobia levels are less motivated and had low achievement in chemistry subjects. Therefore, all parties should work together to overcome chemophobia among students so that the participation of students in the science stream can be improved and get closer to achieving the 60:40 goal.

1.1 Chemophobia

Chemophobia or chemistry anxiety is a phenomenon that often distresses students regardless of the level of study and this problem needs to be addressed as it prevents the process of effective chemistry learning. Chemophobia is also one of the factors of the drop in student participation in chemistry and chemistry-related fields and causes students to lose interest in science (Adeline & Lay, 2014). According to Eddy (2000), there is no clear definition of the term chemophobia. However, chemophobia can be seen based on three main aspects of learning that are: 1) chemistry anxiety, 2) chemistry evaluation anxiety, and 3) fear of chemicals.

Concerns about chemistry learning are among the contributing factors of chemophobia among students. This is because students often have the wrong perception and are often served with untrue stories about chemistry from other students. Most students think chemistry is too complex, abstract and difficult to understand because chemistry not only involves the concept of science but also mathematics (Edaya, 2012; Nuraffandy & Fatimah, 2012).

This causes them to worry and become less motivated to learn chemistry because they feel they are not good enough and ready to learn chemistry. According to a study conducted by Md Nor & Tay (2010), among the

elective science subjects offered, students believe that chemistry is one of the most difficult subjects to be mastered. Concerns about learning difficulties and low levels of academic confidence in science subjects are identified as the main factor causing many students not to choose science stream (Fatin et al, 2012).

Additionally, chemophobia may also be caused by anxiety over chemistry assessments. As we know, education in Malaysia is still examination-oriented where the achievement is measured based on students' performance in examinations such as the Malaysia Certificate of Education (SPM). This is because; the education system in Malaysia has adopted the examination as the main method for assessing students' achievement for over 50 years.

However, the examinations that are highly emphasized in our country's education system have killed the fun of school to the extent that school is synonymous with studying for exams (Rohaya, 2009). The study conducted by Adeline and Lay (2014) found that concern about chemistry assessment is the highest among students. Consequently, many students refused to choose science stream because of fears of low achievement in their exams. This has led the increasing drop in student participation in the recent years.

Additionally, concern about chemicals also contributes to chemophobia among students. According to Ebru and Pinar (2012), the level of anxiety towards chemistry lab activities plays an important role in determining students' attitudes toward chemistry. The findings show that students tend to have anxiety while using chemicals and pay more attention to safety measures while conducting experiments that they disregard the learning activities. As a result, students become less interested in acquiring knowledge through laboratory activities (Edaya, 2012).

Most students are less interested in doing laboratory activities because they worried about the risks if they mistakenly use chemicals during the experiment. Therefore, teachers' supervision during laboratory activities is important to avoid undesirable events and thus reduce their concern when handling the chemicals. In conclusion, all three factors that are chemistry learning anxiety, chemistry assessment anxiety and chemical handling anxiety should be given due attention by all parties so that chemophobia can be completely overcome.

1.2 Students' Attitude towards Chemistry

According to Aiken (1976), attitude can be defined as a tendency to act positively or negatively towards a situations, objects, concepts, institutions or individuals. Attitudes cover three main components that are affective (positive and negative emotions of individuals), behaviors (behaviors associated with attitude) and cognitive (beliefs and thoughts of individuals)

towards an object). These three components are interrelated to form and strengthen one's attitude. This is also happen during the learning process.

Student attitudes are the key to success in learning any subject including chemistry. According to Cheung (2009), attitude towards chemistry can be divided into four aspects namely the enjoyment of learning chemistry, enjoyment of doing chemistry lab activity, the importance of chemistry in life and the behavioral tendency to study chemistry. Normally, when a student has a positive attitude toward a subject, their academic interest and achievement shown will also increase (Aziz & Lin, 2011).

The enjoyment learning of chemistry can be nurtured by the teachers during the teaching and learning (T&L) process. This is because the teacher is an individual that is responsible for creating an attractive learning environment for the students. In order to cultivate enjoyable chemistry lesson, teachers can diversify teaching techniques and provide learning activities that stimulate students to think, and not only accepting the facts and knowledge uttered by the teacher.

According to Nik Zarini and Salmiza (2012), science teaching in Malaysia still emphasizes passive learning of transferring facts without trying to practice inquiry and student-centered approaches although such methods have been proven to foster students' interest in learning science. Student-centered learning is also believed to be one of the ways to foster learning enjoyment among students (Nik Zarini & Salmiza, 2012). If students are happy to learn a subject, they tend to explicitly show their interest in the subject and subsequently get excellent results in the exam (Cheung, 2009). In addition, the excitement of chemistry lab activities also contributes to the positive development of students' attitude toward chemistry. As with other science subjects, laboratory or experimental activities are also a mandatory aspect in chemistry subjects. During laboratory activities, students have the opportunity to conduct experiments to test the theories they have learned in the classroom. According to Cheung (2009), the majority of students are interested in doing activities in the laboratories and this excitement can have a positive influence toward the attitude and interest in chemistry.

This is because laboratory activity gives students the opportunity to search and discover new knowledge through inquiry process by doing the experiments in the lab. By conducting experiments, students will be able to reinforce the theories they have learned in the classroom and at the same time improve their scientific skills such as observing, making hypotheses, solving problems, predicting, communicating, analyzing and so on (Nik Zarini & Salmiza, 2012).

In addition, the importance of chemistry in life is one of the factors that influence students' attitudes toward chemistry. Students should be exposed

to the importance of chemistry in life. This exposure will help to open their eyes on the importance of chemistry and science to improve the quality of life and help to develop the country's economy. This is because; most chemistry-related fields such as agriculture, medicine, and manufacturing as well as materials and food industries use chemistry as the driving force.

However, studies conducted by Adeline and Lay (2014) found that students had a high awareness of the importance of chemistry in life, but did not show a positive attitude towards chemistry due to other factors such lack of enjoyment in studying chemistry. Therefore, teachers play a very important role in shaping students' positive attitude towards chemistry by providing a fun learning experience while emphasizing the importance of chemistry in life.

Additionally, behavioral tendency to study chemistry is also a contributing factor to students' attitudes toward chemistry. Interests (Nor Hamidah & Zanaton, 2014) play an important role in influencing one's actions to do anything whereas internal motivation (Vijaya & Zanaton, 2012) can influence the way students learn, thus affecting the involvement and tendency of student behavior during the T&L process of a subject. If a student has no interest in a subject, then they tend to be passive and not involved in the T&L process (Noorzana, 2013).

Similar things happened in the chemistry T&L process. The study conducted by Nor Hasliza (2012) found that the involvement and interaction of students in the chemistry T&L process are affected because the students are not interested. Students who have no interest in learning something have a tendency to not actively engaged and do other things that may interfere with the T&L (Aziz & Lin, 2011). In conclusion, the four aspects of enjoyment of learning chemistry, enjoyment of conducting chemistry lab activity, the importance of chemistry in life and the behavioral tendency to study chemistry should move in tandem to create a more positive attitude among students.

2. Methodology

This was a survey study to identify chemophobia level, attitude towards chemistry and the relationship between the two. According to Fraenkel, Wallen, and Hyun (2012), the survey design was used to obtain information on attitudes, interests, behaviours, perceptions, factors, and opinions of samples from the studied population. This study involved 101 Form 4 and 5 students from a Federal Religious Secondary School in Bentong who took chemistry subjects using purposive sampling. According to Mohd Najib (2003), the sampling method was to be used when the researcher deliberately chooses the sample to meet the needs of the study.

The instrument used in this study was a questionnaire consisting of 58 items and divided into three parts. Part A contained respondents' demographic information such as gender and level of study. Part B contains 24 items that measure the chemophobia level among students. Chemophobia was measured in three sub categories, which were concerns about chemistry learning, concerns over chemical assessments and concerns about using chemicals. The questionnaire was a five-point Likert scale i.e. Scale 1: not worried, Scale 2: slightly worried, Scale 3: moderately worried, Scale 4: worried and Scale 5: extremely worried. The items in this section were adapted from the instruments used in Eddy (2000).

Part C contained 32 items that measure the level of student attitude towards chemistry which contained four sub-constructs namely the excitement of chemistry learning, the excitement of chemistry lab activity, the importance of chemistry in life and the behavioural tendency to study chemistry. The questionnaire was a five-point Likert scale, Scale 1: strongly disagree, Scale 2: disagree, Scale 3: neutral, Scale 4: agreed and Scale 5: strongly agreed. The items in this section were adapted from the instruments used in Cheung (2009). In order to determine the internal validity and reliability of the items in this questionnaire, an analysis was conducted to obtain alpha coefficients. The items have high validity and reliability in which the alpha coefficient was between 0.915 and 0.945.

Data obtained from the questionnaire were analyzed using Statistical Packages for Social Science (SPSS Version 22.0 for Windows). In order to answer the question about chemophobia and attitude towards chemistry among science stream students, an analysis involving frequency, percentage (%) and mean was used. Meanwhile, Pearson correlation analysis was used to look at the relationship between chemophobia and attitude toward chemistry.

3. Results and Discussion

3.1 Demographic background

The questionnaire was distributed to 101 respondents to identify chemophobia levels, attitudes towards chemistry and the relationship between the two. Table 1 shows a summary of respondents' demographic background. The number of respondents involved in this study was 101 students in which 43 respondents (42.6%) were male and 58 respondents (57.4%) were female.

3.2 Chemophobia level among students

Table 2 showed a summary of chemophobia levels among students. Based on Table 2, the majority of respondents had a moderate chemophobia level

which was 59 students (58.4%). 24 respondents (23.8%) had low chemophobia levels while the rest had high chemophobia (17.8%).

The findings of this study differed from the study conducted by Edaya (2012) which found that students' attitudes and appreciation of chemistry were high but their concerns of chemistry are low. The majority of students have moderate chemophobia levels, but some students have high chemophobia levels. This problem should be taken seriously because students with high chemophobia levels tend to be less motivated and have low achievement in chemistry (Adeline & Lay, 2014).

Table 1. Demographic background

Education level	Gender		Total
	Male	Female	
Form 4	19	31	50
Form 5	24	27	51
Total	43	58	101

Table 2. Chemophobia levels among students

Levels	Score range	Frequency	Percentage
Low	25 – 55	24	23.8
Moderate	56 – 87	59	58.4
High	88 – 120	18	17.8
	Total	101	100

Table 3 showed the factors of chemophobia among students that include chemistry learning anxiety, chemistry assessments anxiety and chemical handling anxiety. The finding showed that chemophobia among students was moderate with mean 2.91.

Chemistry assessments anxiety recorded the highest mean of 3.59 (interpretation: moderate) compared to other chemophobia factors. This showed that students were very worried about the assessments that include tests, quizzes, and examinations. This finding is consistent with the study conducted by Adeline and Lay (2014) which found that chemistry assessment was the highest concern among students.

Chemistry learning anxiety and chemical handling anxiety were at moderate levels with a mean of 2.51 and 2.62. Chemical handling anxiety played an important role in determining the attitude of students towards chemistry (Ebru & Pinar, 2012). These chemophobia factors need to be addressed urgently as they were identified as the main factor causing many students not to choose science stream (Fatin et al, 2012).

Table 3. Mean of chemophobia factors among students

Factors	Mean	Level
Chemistry learning anxiety	2.51	Moderate
Chemistry assessment anxiety	3.59	Moderate
Chemical handling anxiety	2.62	Moderate
Chemophobia among students	2.91	Moderate

3.3 Students' attitude towards chemistry

Table 4 shows a summary of students' attitudes towards chemistry. The majority of respondents (53.5%) had a high level of attitudes towards chemistry. 44.6% respondents had a moderate attitude while the rest had a low attitude towards chemistry 2.0%. These findings were in line with Edaya (2012) which found that students showed high attitudes and appreciation towards chemistry.

However, there were still students with low attitudes towards chemistry because they believe that chemistry was one of the most difficult subjects to be mastered compared to other elective science subjects (Md Nor & Tay, 2010). When students have a positive attitude toward a subject, then their interest was enhanced and subsequently improved the academic achievement (Aziz & Lin, 2011). Hence, the negative attitudes towards chemistry should be reduced because chemistry is important to progress in science as other developed countries.

Table 4. Students' attitude towards chemistry

Level	Score Range	Frequency	Percentage
Low	32 – 74	2	2.0
Moderate	75 – 117	45	44.6
High	118 – 160	54	53.5
	Total	101	100

Table 5 showed the factors affecting attitudes toward chemistry that include the enjoyment of learning chemistry, conducting lab activities, the importance of chemistry in life and behavioral tendency to study chemistry. The findings showed that students' attitudes toward chemistry were at a high level with the mean of 3.70. The excitement of laboratory activity was high and recorded the highest mean of 3.95. This clearly showed that students were very keen to do laboratory activities such as experiments. This finding was consistent with Cheung (2009) which found that the majority of students were interested in doing laboratory activities. The enjoyment of conducting laboratory activities affected positive attitude and interest in chemistry.

The importance of chemistry in life is also at a high level with mean 3.78. This proved that students were aware of the importance of chemistry in everyday life. This finding was in line with the study conducted by Adeline

and Lay (2014) that students have a high awareness of the importance of chemistry in life, but did not show a positive attitude towards chemistry. In addition, the excitement of chemistry learning and behavioral tendencies for studying chemistry was at a moderate level with the mean of 3.49 and 3.59. The learning enjoyment played an important role in nurturing students' positive attitude towards chemistry. If students were happy to learn a subject, they tend to show positive interest in the subject then get excellent results in the exam (Cheung, 2009).

Table 5. Mean of students' attitude towards chemistry

Factor	Mean	Level
The enjoyment of learning chemistry	3.49	Moderate
The enjoyment of conducting chemistry lab activity	3.95	High
The importance of chemistry in life	3.78	High
Behavioral tendency to study chemistry	3.59	Moderate
Attitude towards chemistry	3.70	High

3.4 The relationship between chemophobia among students and their attitude toward chemistry

Table 6 showed that there was a significant negative correlation between chemophobia and students' attitude toward chemistry. Chemistry assessments anxiety ($r = -.391$, $p < .01$) showed the highest negative relationship compared to two other factors. Chemical handling anxiety ($r = -.275$, $p < .01$) and chemistry learning anxiety ($r = -.190$, $p < .01$) also showed significant negative correlation with students' attitude toward chemistry. In summary, there was a moderate negative significant relationship ($r = -.358$, $p < .01$) between three chemophobia factors and students' attitude towards chemistry.

The findings of this study have successfully rejected the first hypothesis $H_0(1)$ which stated that there is no significant correlation between chemophobia and students' attitude towards chemistry. This negative relationship proved that the lower the chemophobia among students, the higher the student attitude towards chemistry. This was supported by Edaya (2012) that students' attitude and appreciation of chemistry was high but their confidence in chemistry was low. Adeline and Lay (2014) in their study also found that students with high chemophobia levels tend to be less motivated and have low achievement in chemistry.

3.5 The influence of chemophobia factors on students' attitudes toward chemistry

Table 7 showed the summary of multiple regression analysis on the effects of chemophobia factors on student attitudes. Multiple analysis was conducted and found that overall regression model was significant [$F(3, 97) = 6.78$ and $R^2 = 0.173$]. Chemistry assessment anxiety ($\beta = -.374$, $t = -3.312$,

p <.05) was a significant predictor of attitudes toward chemistry in this study. The regression coefficient, $R^2=0.173$ indicates that 17.3% change of student attitude toward chemistry was due to the change in the second predictor variable that was concerns about chemistry assessment. Based on the results of the multiple regression analysis, it can be concluded that the second hypothesis H0 (2) which stated that chemophobia factor does not significantly affect the attitude of the students towards chemistry was rejected.

Table 6. Relationship between chemophobia and attitude towards chemistry

	Chemistry learning anxiety factor	Chemistry assessment anxiety factor	Chemical handling anxiety factor	The three chemophobia factors
Attitude towards chemistry	-.190**	-.391**	-.275**	-.358**

** Significant level <0.01

Table 7. Multiple regression analysis summary

Variables	B	Standard Error	Beta, β	R^2	t	Sig, p
(Constant)	149.740	7.779			19.250	.000
Factor 1	.297	.363	.096		.817	.416
Factor 2	-.957	.289	-.374	.173	-3.312	.001
Factor 3	-.465	.313	-.163		-1.483	.141

** Significant level at <.05

This study suggested government should make improvements to the education system in Malaysia so as not to be too examinations oriented. The findings showed that chemistry assessment concerns have the highest mean. This proved that students are more likely to be concerned with assessments such as tests and exams because they are worried about getting a low score. The high emphasis of examinations has killed the fun of schooling that the school is synonymous with studying for the examination. Subsequently, many students refuse to opt for science stream because they worried about low achievement in their exams.

In addition, teacher-centered learning approaches also need to be changed to student-centered learning approach. Teachers can use student-centered learning approaches such as project-based learning, cooperative learning, and discovery inquiries. This is because, a student-centered learning approach is able to attract students to explore a topic and thus make the learning process a fun activity. When students are happy to learn science, they are encouraged to have a positive attitude towards science and to apply the knowledge gained in the classroom into their daily lives. The application

of learning in everyday life will enhance scientific literacy among students and also attract students to study science at the higher levels.

Additionally, parents should instill deep interest in their children to learn science. Deep interest in science can be sown since childhood by doing various activities such as making a simple experiment using materials that are available at home and linking it to the science concept. This will encourage little ones to learn more about science-related things because they feel excited. Parents can also incorporate science elements through entertainment such as watching science-related documentaries, watching science-related films, and playing science games. Learning science through entertainment not only stimulates children to be active, but also makes learning a fun process.

4. Conclusion

Based on the findings, chemophobia among students was at a moderate level while students' attitude towards chemistry was at a high level. The findings also showed that there was a moderate negative significance correlation between the three chemophobia factors and the students' attitude toward chemistry. Multiple regression analysis also found that the chemistry assessment anxiety contributes to students' attitudes toward chemistry. This is in line with the findings of correlation analysis which suggest that chemistry assessment anxiety showed the highest negative correlation over learning anxiety factor and the use of chemicals. Various steps can be taken to overcome chemophobia such as applying student-centered learning and improve education system so that it will be less exam-oriented. In conclusion, chemophobia among students should be addressed urgently to foster positive attitudes, improve academic achievement and increase student participation in science and chemistry-related fields so that highly skilled and innovative human capital can be produced in line with the Malaysian government's aspirations.

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