# Malaysian Science Stream Students' Anxiety Towards Chemistry at the Secondary School Level

**Nor Fariha Kamaruddin, Nor Hasniza Ibrahim, Johari Surif, Marlina Ali, Corrienna Abd Talib, Noru lhuda Ismail**

***Abstract :This study investigated the extent of anxiety towards chemistry that exists among science stream students at the secondary school level in urban and rural schools. The research design of this study was a mixed method research design. Upper secondary school students (n = 258) participated in the study which was conducted in the district of Johor Bahru, Malaysia. The questionnaire was developed to explore the attribution factor of chemistry anxiety that included learning chemistry anxiety, chemistry evaluation anxiety and handling chemicals anxiety. In order to provide richer interpretation of chemistry anxiety, the Rasch model analysis was performed to support the inferential analysis and thematic analysis conducted in this study. The results showed a significant difference in the chemistry anxiety that existed among science stream students in urban and rural schools. Indeed, appropriate further actions by educators should be implemented in order to reduce the existence of chemistry anxiety among students.***

## I. INTRODUCTION

Anxiety is an affective factor that describes the degree of fear towards a particular object or situation. Uncontrolled anxiety is a common emotional difficulty and is predominantly experienced by youth. The existence of unwelcome anxiety among students in their learning tends to cause them academic difficulties and also influences their development process as part of a holistic society . Moreover, anxiety is a psychological phenomenon that affects students' attitudes towards their learning process. In basic terms, the learning processes of a student include the domain of knowledge, motivation and anxiety. Students may have ample knowledge and receive positive boosters to be motivated in their learning process.

Nevertheless, the presence of undesirable anxiety may influence their learning performance and may worsen when they are unable to demonstrate their abilities, competencies and proficiency skills in their learning process efficiently [17].

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## II. CHEMISTRY ANXIETY

Chemophobia can be simplified as phobic anxiety that relates to the fear of chemicals and fear of chemistry as a course[16]. Seligmen and Wuyek) found that highly anxious students are significantly more likely to gain lower scores in terms of academic attainment. Chemistry anxiety mainly influences an individual's apprehension towards the subject of chemistry mainly in learning chemistry, evaluative situations related to chemistry either in assessments or examinations and also experiencing apprehension and fear while handling chemicals in the laboratory setting. Chemistry anxiety is one of the learning obstacles that inhibit the growth of excellent students in the chemistry discipline [1][18].

### A.Perception of Students towards Chemistry

Chemistry has intimidated secondary school students due to negative perceptions such as the belief that chemistry is a dangerous subject to learn, that exposure to hazardous chemicals is a risk, that chemistry is related to the study of explosions, and that the study of chemistry involves facing difficulties in solving numerical problems and understanding the principles of chemistry, memorization of abstract facts and concepts. Other negative perceptions among students include the stereotypical view of chemists as *nerdy* with *mad hair*, wearing lab coats and glasses and that the work of a chemist or scientist is dull and isolating [3].

### B.Enrolment of Malaysian students in science stream course

The enrolment of Malaysian students in science stream courses at the secondary school level has dropped drastically to a critical level of 27% since 2007 and this decline has also been seen at the tertiary level particularly in science courses (Bernama News, 2012). This issue may influence the efforts of the Malaysian Government in placing Malaysia as a high income country specifically in the advancement of technological innovation in the near future. Additionally, the target of the Malaysian Science and Technology Human Capital Direction Plan 2020 in accomplishing the requirement of 60% enrolment of Malaysian students in the science stream and 40% of Malaysian students in the art stream has not yet been achieved[12].

**C.Achievement of Malaysian secondary school students**

In terms of Malaysian achievement at the international level, Malaysian secondary school students' were ranked at the level of 75 compared to other top countries' achievement in the*46th of International Chemistry Olympiad* held in Hanoi, Vietnam, in 2014. Malaysian students' achievement in the*Programme of International Student Assessment* and *Trends in Mathematics and Science Study* also indicated lower attainment. Indeed, Malaysian secondary school students were left behind in terms of students' performance at the global level and this result sounded the alarm to the Malaysian educational system in regard to students' achievement and performance[2].

**D.Determination of chemistry anxiety exists among secondary school students**

The teaching and learning process must include positive interaction between teachers and students. However, traditional teaching methods are still primarily practiced by Malaysian teachers whereby they are fully responsible for transferring the knowledge to the students (Tan and Arshad, 2011)[4].

In the previous educational research on these issues, there are knowledge gaps that need to be addressed. The present study aimed to bridge these gaps and thereby make a contribution to this area of study. Therefore, this study intended to investigate the extent of chemistry anxiety among science stream students at the secondary school level particularly in learning chemistry, chemistry evaluation and handling chemicals. The determination of chemistry anxiety among secondary school students is essential to help the students, educators and schools develop preventive interventions to enhance science stream students' interest and engagement towards chemistry. This will create the pathway for students to improve their performance in chemistry education, strengthen students' enthusiasm and self-efficacy towards chemistry and view chemistry as an interesting subject.

**D.Theoretical framework**

The trait-state anxiety theory developed by Charles D. provided a comprehensive framework for the interpretation of this study's findings. Spielberger defined anxiety as an unpleasant emotional state which is characterized by subjective feelings of tension, uneasiness, fear or worry by a trigger or a stimulation of the autonomic nervous system. In trait-state anxiety theory, the state anxiety and trait anxiety expressed by a person are the source of anxiety. Anxiety state (A-State) is demonstrated by an individual when they personally perceive a particular situation as risky or threatening. Trait anxiety (A-Trait) is inferred from the individual who has elevated A-State anxiety that is frequently and intensely over the time. A person who has trait anxiety usually has state anxiety but a person who perceives state anxiety would not necessarily be described as having trait anxiety.

A number of standard assumptions of this theory can be briefly described. For example, if there is a situation or condition which an individual generally perceives as intimidating and threatening, A-anxiety will occur. A person may experience unpleasant state anxiety when they detect difficulties through the feedback mechanism of the sensory and cognitive system. In terms of the intensity of an A-State reaction, it will be related to the amount of threat that the situation poses to the individual. Another assumption is that the determination of the individual in interpreting the situation as threatening will contribute to the duration of the A-state reaction to be endured. A high A-Trait person will perceive a situation or condition that may trigger a threat or a failure to be more risky and threatening than a person with low A-Trait anxiety. Moreover, A-State elevation comprises drive and stimulus properties that may be detected in a person's behavior and may create an effective defence to reduce the A-State experienced on previous occasion. The final assumption is that an individual is able to develop particular coping responses to the traumatic situation that is encountered regularly.

## III .METHODS

At the outset of the study, a mixed method design was used. This method involves collecting, analyzing and mixing quantitative and qualitative data in a single study.

**A.Selection of respondents and research location**

The selection of respondents and research location is essential stages in a study in order to accomplish the study's objectives and investigate the topic effectively. The respondents in this research were selected from the population of science stream students at secondary school level. The research location was Johor Bahru District, Malaysia.

The population of respondents is science stream students in Johor Bahru and was obtained from multi-stage sampling. From the population of 2820 science stream students, the research sample of this study comprised 340 science stream students from six secondary schools who were selected by the random sampling technique. During the period of data collection, 258 science stream students from urban and rural schools completely responded to the distributed questionnaires.

**B.Participant consent**

Permission to run the investigation was obtained from the secondary school's principal prior to the researcher collecting the data from the students for a pilot test study and prior to collecting the real data from the respondents. In the process of collecting the data, all the participants who had been selected as part of the research sample were asked to respond to the chemistry anxiety questionnaire that was provided by the researcher to them. The purpose of the data collection for this research was explained to the respondent before the researcher carried out the investigation[9].

**C.Research Instrument**

The study adapted the quantitative instrument from established instruments, namely, the Derived Chemistry Anxiety Rating Scale), the Chemistry Laboratory Anxiety Instrument (CLAI) (Bowen, 1999) and the Science Anxiety Scale (SAS) [5].

The qualitative part of this research was in the form of open-ended questions which were developed by the researcher. These questions were related to chemistry anxiety in terms of learning, evaluation and handling chemicals. The research instrument of this study consisted of three sections. Section A covered the demographic profile and background of the respondent, Section B was the chemistry anxiety questionnaire with 25 subscale items, and Section C consisted of five open-ended questions. A four point scale questionnaire consisting of25 items was used as the primary database for this study. The four point scale was represented by 1 for strongly disagree, 2 for disagree, 3 for agree and 4 for strongly agree. The answers to the open-ended questions were used and analyzed as the qualitative data for this research in order to support the quantitative data. The research participants were asked to give a response to the following questions: 1) what do you feel if you cannot understand the chemistry topic taught by the teacher in a classroom? 2) How would you feel if you get low marks in a chemistry test or chemistry examination? 3) Can you tell me more about why you feel like that?4) How do you feel when you are handling chemicals in the chemistry laboratory? 5) Do you feel like that every time that you need to do a chemistry experiment?

**D.Content validity**

The research instrument of this study was validated by educational experts who represented a professional group in the education field and included an expert in chemistry education, an expert in measurement and evaluation and an expert in guidance and counselling. In regard to content validation, the three experts reviewed the research instruments and evaluated each subscale item for each chemistry anxiety construct and also the open-ended questions developed by the researcher based on the objectives of the research.

**E.Construct validity**

Rasch analysis was used to verify the construct validity of the four point scale questionnaire from the data collected in the pilot study. Figure 1 presents the item measure for 27 items from the three main constructs of the chemistry anxiety dimension. Based on Figure 1, the main criteria that were determined in order to observe the misfit item were the Outfit Mean Square (MNSQ) and Z standardized (ZSTD) values. The outfit MNSQ value of each item should be in the range of 0.5 to 1.5 and the ZSTD score must be located within the range of -1.9 to 1.9). The Rasch measurement proposed by Linacre) was purposely used in this study. Hence, if the item did not fulfil the requirement, the item is required to be omitted. A total of 25 items were reported to be fit and two items should be eliminated (item 15 and item 27). The Outfit MNSQ of item 15 was in range but the Outfit ZSTD value was not in the acceptable range (the data was too predictable), while item 27 indicated an unacceptable requirement value for Outfit MNSQ and Outfit ZSTD. Therefore, 25 items from the chemistry anxiety questionnaire were validated and used in the further research[6].

ITEM STATISTICS: ENTRY ORDER

| ENTRY NUMBER | TOTAL SCORE | TOTAL COUNT | MEASURE | MODEL S.E. | INFIT MNSQ | INFIT ZSTD | OUTFIT MNSQ | OUTFIT ZSTD | PT-MEASURE CORR. | PT-MEASURE EXP. | EXACT MATCH OBS% | EXACT MATCH EXP% | ITEM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 93 | 38 | .60 | .24 | .81 | -.9 | .80 | -.9 | .64 | .58 | 57.9 | 53.6 | LCA1_NEW |
| 2 | 97 | 38 | .36 | .24 | .71 | -1.4 | .71 | -1.4 | .74 | .58 | 57.9 | 54.3 | LCA2_REA |
| 3 | 85 | 38 | 1.06 | .24 | .72 | -1.4 | .71 | -1.4 | .67 | .57 | 57.9 | 51.9 | LCA3_FRI |
| 4 | 75 | 38 | 1.66 | .25 | .64 | -1.8 | .64 | -1.7 | .62 | .55 | 71.1 | 54.5 | LCA4_SEE |
| 5 | 97 | 38 | .36 | .24 | 1.25 | 1.1 | 1.21 | 1.0 | .61 | .58 | 50.0 | 54.3 | LCA5_THI |
| 6 | 106 | 38 | -.17 | .25 | 1.26 | 1.2 | 1.20 | .9 | .57 | .58 | 52.6 | 55.6 | LCA6_ENR |
| 7 | 107 | 38 | -.23 | .25 | 1.03 | .2 | 1.04 | .2 | .62 | .58 | 55.3 | 55.8 | LCA7_SOL |
| 8 | 77 | 38 | 1.54 | .25 | 1.23 | 1.1 | 1.19 | .9 | .36 | .55 | 55.3 | 53.8 | LCA8_USE |
| 9 | 94 | 38 | .54 | .24 | 1.27 | 1.2 | 1.31 | 1.4 | .54 | .58 | 47.4 | 53.7 | LCA9_MEM |
| 10 | 92 | 38 | .66 | .24 | .81 | -.9 | .79 | -1.0 | .68 | .58 | 57.9 | 53.1 | LCA10_WA |
| 11 | 88 | 38 | .89 | .24 | .88 | -.5 | .92 | -.3 | .42 | .57 | 55.3 | 52.4 | LCA11_HE |
| 12 | 117 | 38 | -.87 | .26 | 1.00 | .1 | .98 | .0 | .58 | .58 | 52.6 | 55.5 | LCA12_AS |
| 13 | 116 | 38 | -.80 | .26 | .75 | -1.2 | .74 | -1.2 | .67 | .58 | 68.4 | 55.4 | CEA1_EVA |
| 14 | 133 | 38 | -2.09 | .30 | 1.20 | .9 | 1.13 | .5 | .54 | .54 | 60.5 | 65.2 | CEA2_WAI |
| 15 | 114 | 38 | -.67 | .25 | .47 | -2.9 | .51 | -2.7 | .63 | .58 | 81.6 | 55.4 | CEA3_TEA |
| 16 | 119 | 38 | -1.01 | .26 | .79 | -1.0 | .77 | -1.1 | .79 | .57 | 60.5 | 55.4 | CEA4_SIT |
| 17 | 112 | 38 | -.55 | .25 | 1.19 | .9 | 1.18 | .8 | .65 | .58 | 44.7 | 55.5 | CEA5_LOT |
| 18 | 130 | 38 | -1.83 | .29 | 1.34 | 1.4 | 1.25 | 1.0 | .49 | .55 | 63.2 | 61.9 | CEA6_SIT |
| 19 | 108 | 38 | -.30 | .25 | 1.01 | .1 | .98 | .0 | .55 | .58 | 63.2 | 55.8 | CEA7_TEA |
| 20 | 101 | 38 | .13 | .24 | .95 | -.2 | .96 | -.1 | .63 | .58 | 50.0 | 55.3 | CHA1_HAN |
| 21 | 109 | 38 | -.36 | .25 | 1.38 | 1.6 | 1.44 | 1.9 | .33 | .58 | 52.6 | 55.8 | CHA2_HEA |
| 22 | 96 | 38 | .42 | .24 | .84 | -.7 | .84 | -.7 | .49 | .58 | 50.0 | 54.0 | CHA3_IDE |
| 23 | 111 | 38 | -.48 | .25 | 1.16 | .8 | 1.11 | .6 | .57 | .58 | 50.0 | 55.7 | CHA4_USE |
| 24 | 97 | 38 | .36 | .24 | .74 | -1.2 | .72 | -1.3 | .64 | .58 | 65.8 | 54.3 | CHA5_HOL |
| 25 | 110 | 38 | -.42 | .25 | 1.14 | .7 | 1.21 | 1.0 | .48 | .58 | 55.3 | 55.8 | CHA6_USE |
| 26 | 94 | 38 | .54 | .24 | .74 | -1.2 | .82 | -.8 | .61 | .58 | 60.5 | 53.7 | CHA7_CON |
| 27 | 92 | 38 | .66 | .24 | 1.84 | 3.2 | 1.82 | 3.1 | .49 | .58 | 39.5 | 53.1 | CHA8_COM |
| MEAN | 102.6 | 38.0 | .00 | .25 | 1.01 | .0 | 1.00 | -.1 | | | 56.9 | 55.2 | |
| S.D. | 14.0 | .0 | .88 | .01 | .29 | 1.3 | .28 | 1.2 | | | 8.5 | 2.6 | |

**Figure 1** Item Statistics

**F.Reliability**

The reliability of the research instrument was obtained from the Rasch analysis. As shown in Figure 2, the person reliability was 0.91 (with a separation of 3.22). As shown in Figure 3, the item reliability was 0.91(with a separation of 3.27). According to Fischer (2002), the reliability value in the range of 0.91 to 0.94is very good and the separation of item and person in the range of 3.00 to 4.00 is good. Thus, the chemistry anxiety instrument in the present study was sensitive enough to distinguish the most and less anxious respondents from the sample of the pilot study[13].

SUMMARY OF 38 MEASURED PERSON

| | TOTAL SCORE | COUNT | MEASURE | MODEL ERROR | INFIT MNSQ | INFIT ZSTD | OUTFIT MNSQ | OUTFIT ZSTD |
|---|---|---|---|---|---|---|---|---|
| MEAN | 72.9 | 27.0 | .43 | .30 | 1.01 | -.1 | 1.00 | -.1 |
| S.D. | 12.4 | .0 | 1.11 | .03 | .44 | 1.7 | .42 | 1.6 |
| MAX. | 98.0 | 27.0 | 2.93 | .41 | 2.13 | 3.5 | 2.10 | 3.5 |
| MIN. | 35.0 | 27.0 | -3.20 | .28 | .26 | -4.1 | .28 | -3.9 |

REAL RMSE .33 TRUE SD 1.06 SEPARATION 3.22 PERSON RELIABILITY .91
MODEL RMSE .30 TRUE SD 1.07 SEPARATION 3.56 PERSON RELIABILITY .93
S.E. OF PERSON MEAN = .18

**Figure 2** Reliability of person for a pilot test study


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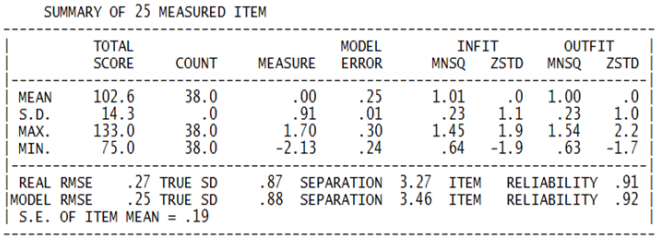

SUMMARY OF 25 MEASURED ITEM

| | TOTAL SCORE | COUNT | MEASURE | MODEL ERROR | INFIT MNSQ | INFIT ZSTD | OUTFIT MNSQ | OUTFIT ZSTD |
|---|---|---|---|---|---|---|---|---|
| MEAN | 102.6 | 38.0 | .00 | .25 | 1.01 | .0 | 1.00 | .0 |
| S.D. | 14.3 | .0 | .91 | .01 | .23 | 1.1 | .23 | 1.0 |
| MAX. | 133.0 | 38.0 | 1.70 | .30 | 1.45 | 1.9 | 1.54 | 2.2 |
| MIN. | 75.0 | 38.0 | -2.13 | .24 | .64 | -1.9 | .63 | -1.7 |

REAL RMSE .27 TRUE SD .87 SEPARATION 3.27 ITEM RELIABILITY .91
MODEL RMSE .25 TRUE SD .88 SEPARATION 3.46 ITEM RELIABILITY .92
S.E. OF ITEM MEAN = .19

**Figure 3** Reliability of item for a pilot test study

**Analyses**

The Statistical Package for Social Science (SPPS) and Rasch model measurement were used to analyze the data collected from the research sample. SPSS analysis was used to report the descriptive statistics to answer the first research question. Rasch analysis was used to assist the researcher to conduct inferential statistics by enabling the polytomous ordinal data of the four point scale questionnaire to be converted into interval polytomous data. Interval polytomous data was purposely used to conduct inferential statistics in SPSS analysis in order to investigate the second research question. Rasch analysis also assisted the thematic analysis of the open-ended questionnaire in order to support the quantitative findings of this study.

## IV.RESULTS

The descriptive statistics approach was used to answer the first research question posed in this study. The following research questions were used to guide the analysis:

Research Question 1: What is the extent of science stream students' anxiety towards chemistry in the aspects of chemistry learning, chemistry evaluation and handling chemicals according to the different type of school background in Johor Bahru, Malaysia?

Table 1 presents the results of the SPSS analysis of the profile of the 258 respondents in this study. Half of the students had an urban school background, and half had a rural school background. Table 2 presents the results of the SPSS analysis on the frequency and percentage of science stream students' perceived chemistry anxiety in the urban and rural schools in terms of learning chemistry. Table 3 presents the frequency and percentage of science stream students' perceived chemistry evaluation anxiety in the urban and rural schools. Table 4 presents the frequency and percentage of science stream students' perceived handling chemicals anxiety in the urban and rural schools.

**Table1** Respondent profile of the study

| Characteristic of Demography | Total sample | Frequency of sample, N | Percentage (%) |
|---|---|---|---|
| Urban School Background | N = 258 | 129 | 50.0 |
| Rural School Background | | 129 | 50.0 |

**Table 2** Frequency and percentage of science stream students perceived chemistry learning anxiety in urban and rural schools

| Chemistry Evaluation Anxiety | Frequency (Percentage %) SD | D | A | SA |
|---|---|---|---|---|
| I feel anxious when I wait to get the marks from a chemistry test. | 5(3.9)* 14(10.9) | 20(15.5)* 22(17.1) | 64(49.6)* 54(41.9) | 40(31.0)* 39(30.2) |
| I feel anxious when I wait to get the marks from a chemistry test. | 5(3.9)* 18(14.0) | 20(15.5)* 26 (20.2) | 72(55.8)* 48 (37.2) | 32(24.8)* 37 (28.7) |
| I feel anxious when a teacher evaluates me in solving a chemistry problem in front of the class. | 7(5.4)* 18(14.0) | 36(27.9)* 37(28.7) | 73(56.6)* 55(42.6) | 13(10.1)* 19(14.7) |
| I feel anxious when I take a chemistry test. | 6(4.7)* 10(7.8) | 29(22.5)* 40(31.0) | 72(55.8)* 53(41.1) | 22(17.1)* 26(20.2) |
| I feel anxious when I am being given homework about difficult chemistry problems which is required to be submitted in the next class. | 15(11.6)* 18(14.0) | 53(41.1)* 44(34.1) | 51(39.5)* 49(38.0) | 10(7.8)* 18(14.0) |

**Table 3** Frequency and percentage of science stream students perceived chemistry evaluation anxiety in urban and rural schools

| Chemistry Evaluation Anxiety | Frequency (Percentage %) SD | D | A | SA |
|---|---|---|---|---|
| I feel anxious when a chemistry teacher observes my work when I conduct an experiment in the laboratory. | 12(9.3)* 25(19.4) | 48(37.2)* 41(31.8) | 56(43.4)* 48(37.2) | 13(10.1)* 15(11.6) |

*represent the finding of urban schools and vice versa.
SD= strongly agree, D= disagree,
A=agree, SA = strongly agree



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**Table 4** Frequency and percentage of science stream students perceived handling chemicals anxiety in urban and rural schools

| Handling Chemicals Anxiety | Frequency (Percentage %) | | | |
|---|---|---|---|---|
| | SD | D | A | SA |
| I feel anxious when I listen to another student describe an accident in the chemistry laboratory. | 23(17.8)* 31 (24.0) | 49(38.0)* 46(35.7) | 50(38.8)* 39 (30.2) | 7(5.4)* 13(10.1) |
| I feel anxious when I work with an unknown chemical. | 18(14.0)* 27 (20.9) | 45(34.9)* 37(28.7) | 53(41.1)* 56(43.4) | 13(10.1)* 9 (7.0) |

*represent the finding of urban schools and vice versa.
SD= strongly agree, D= disagree, A=agree, SA = strongly agree

Inferential statistics were used in this study to test the alternative hypotheses of the research in order to make generalizations about the population from which the respondents were selected. The comparison of chemistry anxiety was analyzed in regard to learning chemistry anxiety, chemistry evaluation anxiety and handling s

tandard deviation =1.54) and handling chemicals anxiety (M = 2.78, SD = 2.29) reported by the science stream students in the urban schools in Johor Bahru were slightly higher than for the science stream students in the rural schools (chemistry evaluation anxiety: M = 3.41, SD =1.66; handling chemicals anxiety: M = 2.36, SD = 2.30). However, the mean score of learning chemistry anxiety demonstrated by the science stream students in the rural schools (M = 4.98, SD = 3.09) was marginally higher than the mean score for the science students in the urban schools (M = 4.53, SD = 2.94) in Johor Bahru, Malaysia.

This study applied the Wilks'Lambda for the F-test. Table 6 presents the multivariate tests table whereby the significance level for the chemistry anxiety dimensions between both school backgrounds was 0.007 (i.e. less than 0.05). Therefore, there was a statistically significant difference between urban school background and rural school background in terms of science stream students' anxiety about chemistry, F (3, 254) = 4.14, $p$ = 0.007; Wilk's Lambda = 0.95; partial eta squared = 0.047.

**Table 6** Multivariate Test

| | School Background | Mean | Standard Deviation | n |
|---|---|---|---|---|
| Learning chemistry anxiety | Urban School | 4.53 | 2.94 | 129 |
| | Rural School | 4.98 | 3.02 | 129 |
| | Total | 4.83 | 3.03 | 258 |
| Chemistry Evaluation Anxiety | Urban School | 3.70 | 1.54 | 129 |
| | Rural School | 3.41 | 1.66 | 129 |
| | Total | 3.56 | 1.60 | 258 |
| Chemical Handling | Urban School | 2.78 | 2.29 | 129 |
| | Rural School | 2.36 | 2.30 | 129 |
| | Total | 2.57 | 2.30 | 258 |

chemicals anxiety. The MANOVA analysis was performed to report the findings and answer the second research question which focused in particular on science stream students from different school backgrounds. The second research question was used to guide the analysis:

Research Question 2: Is there any difference in the chemistry anxiety that exists among the science stream students in rural and urban schools in Johor Bahru, Malaysia?

**Table 5** Mean score of chemistry anxiety

| Effect | Statistics | Value | F | Sig. |
|---|---|---|---|---|
| School Background | Pillai's Trace | .047 | 4.14 | .007 |
| | Wilks' Lambda | .953 | 4.14 | .007 |
| | Hoteling's Trace | .049 | 4.14 | .007 |
| | Roy's Largest Root | .049 | 4.14 | .007 |

Table 5 presents the mean scores of chemistry anxiety that were generated from the SPSS analysis. MANOVA analysis was selected to interpret the data in this study because it is an extension of the analysis of variance when a researcher has more than one dependent variable.

In this study, there were three dependent variables of chemistry anxiety, namely, learning chemistry anxiety, chemistry evaluation anxiety and chemical handling anxiety. The inspection of the mean scores showed that the mean score of chemistry evaluation anxiety (mean = 4.83,

Anxiety

Thematic analysis is one of the techniques of qualitative analysis that was embedded in this study in order to support the quantitative analysis. The thematic analysis was performed with the assistance of the person-item distribution map obtained from the Rasch measurement (Winstep Version 3.72.3). The Rasch model analysis offers a distribution map analysis as a way of exploring the characteristics of affective factors emerging from that particular construct of a research instrument meaningfully and intensely. In this study, the science stream students represented an individual or group of students that expressed their anxiety level on the specific chemistry anxiety construct. The person-item map developed from the Rasch analysis was used to describe the distribution of the highly-anxious, moderately-anxious students and low-anxious students in respect of each school background.

Indeed, the identification of the particular students distributed on the person-item map was beneficial for conducting the thematic analysis. The thematic analysis was performed by highlighting the students who apparently represented the highly-anxious students in order to investigate deeply the tendency of chemophobia among science stream students in different school backgrounds.

Based on Figure 4, *1S* was defined as science stream students in urban schools and *x* was denoted as the questionnaire items that were used in this research. Referring to Figure 4, thirteen out of 129 science stream students (*1S45, 1S89, 1S5, 1S52, 1S81, 1S82, 1S101, 1S11, 1S51, 1S106, 1S53, 1S74* and *1S69*) in urban schools in Johor Bahru demonstrated orders that were more than one standard deviation above the mean. This meant that they represented the science stream students in urban schools who were *most anxious* about the attribution factors of chemistry anxiety investigated in this study.


**Figure4** person-item distribution map of science stream in urban schools

There were three science students (*1S107, 1S120* and *1S43*) in urban schools in Johor Bahru whose orders were under the scale of more than one standard deviation below the mean value and this characterized them as low-anxious students towards chemistry subject. The group of research participants saturated at the distribution of item constructs exhibited a group of students who were moderately anxious in all the attributed factors of chemistry anxiety as stated in the research.

In Figure 5, the notation of *2S* signified science stream students of rural schools in Johor Bahru while *x* represented the items belonging to chemistry anxiety constructs. Of the 129 respondents in rural schools in Johor Bahru, 18 were gathered at the scale at more than one standard deviation above the mean value. This group of 18 respondents (*2S129, 2S3, 2S61, 2S67, 2S92, 2S59, 2S6, 2S72, 2S75, 2S81, 2S55, 2S28, 2S39, 2S94, 2S64, 2S65, 2S104* and *2S102*) comprised the group of highly-anxious science stream students in rural schools. Of the 129 respondents (*2S106, 2S114, 2S45, 2S23, 2S112, 2S125, 2S17, 2S117, 2S110*) in rural schools in Johor Bahru, nine were classified as low-anxious students. The rest of the respondents represented the majority of science stream students who were moderately anxious about chemistry.

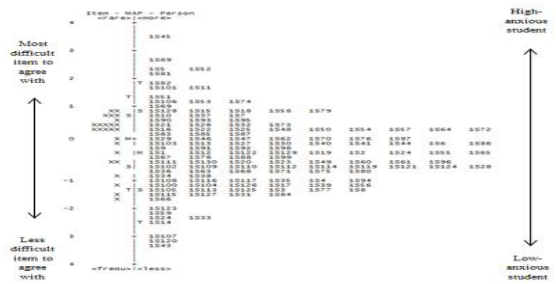


**Figure 5** person-item distribution map of science stream in rural schools

As explained above, the focus group that was purposely investigated in this study was highly-anxious students in urban schools and rural schools in Johor Bahru, Malaysia. The investigation of the highly-anxious students was generally supported by the open-ended data that represented the responses from students. The themes that emerged from the science stream students' answers to the open-ended questions from both school backgrounds included self-perception, anxiety, self-efficacy and stress. Then, the findings of this thematic analysis were used to support the quantitative findings of the research.

## IV.DISCUSSION

**Investigation of learning chemistry anxiety among science stream students in urban and rural schools**

Generally, there were four learning chemistry construct items that were clearly selected by the science stream students in expressing their learning chemistry anxiety, namely, anxiety in solving difficult problems in chemistry tests, anxiety about explaining the ways to solve chemistry problems in front of the classroom, anxiety about learning new topics of chemistry, and anxiety about reading chemistry formula. Anxiety in solving difficult problems in chemistry tests and anxiety about explaining the ways to solve chemistry problems in front of the classroom were the learning chemistry items that were agreed upon by the science stream students in both school backgrounds. Undoubtedly, the results showed that science stream students tended to feel anxious when the learning process was related to complex chemistry problems either in the general learning process or in the assessment setting. This finding is similar to the research outcomes of Nelson and Harwood (2011) who asserted that students probably suffer anxiety when facing difficult tasks in their chemistry learning.

In regard to learning chemistry anxiety, it appears that the science stream students in both school backgrounds are required to acquire problem solving skills particularly in the chemistry subject in order to prevent the anxiety phenomenon from interfering with their learning process. According to Sirhan (2007), science stream students are likely to be anxious about learning chemistry when they cannot effectively interpret the abstract knowledge of chemistry in terms of theories, concepts, principles or problem solving calculations. In addition, a difference in the learning experience perceived by science stream students also was presumed as the other reason causing them to be anxious about solving chemistry problems. Some students may perceive that they had experienced poor teaching methods while others may express that they had experienced good teaching (Springate et al., 2008).

According to Tan and Arshad (2011), traditional teaching was mainly still practiced by Malaysian teachers by which teachers are fully responsible for transferring the knowledge of the subject to the students. Teaching and learning processes must involve a positive interaction between teachers and students. Implementation of one-way delivery from a teacher does not lead to an effective

learning approach in terms of the vast majority of students. Indeed, appropriate learning strategies in the classroom or laboratory setting can help to enhance science stream students' engagement as well as to develop their positive attitudes towards learning chemistry and also as a way to help reduce their anxiety about learning chemistry (Kurbanoglu and Akim, 2010).

Moreover, it was found that science stream students in rural schools perceived anxiety in learning new topics in chemistry. The existence of anxiety towards the learning of new chemistry topics may be due to deficiency in the understanding of science stream students regarding the chemistry representational system which includes the macroscopic level, microscopic level and symbolic level. The interactions between those representational elements are substantial characteristics of the chemistry learning process and required for accomplishment in understanding chemical concepts. Consequently, if science stream students have difficulties at one of the levels, it will have a negative impact on those science stream students in rural schools and lead to perceived anxiety when their chemistry teacher starts a new topic involving the learning of chemistry (Chen 2013)[10].

The science stream students in rural schools also indicated that they perceived anxiety about reading chemistry formula. This finding indicated that science stream students in rural schools generally faced difficulty in understanding chemical formulae compared to science stream students in urban schools. The existence of anxiety towards this learning chemistry item may be due to science stream students in rural schools not mastering the symbolic level of the chemistry representative system. The chemistry teacher as the instructor was responsible for delivering and transferring the knowledge related to the learning of chemistry to all the students in a classroom or laboratory setting. Thus, acquirement of pedagogical content knowledge by the chemistry teacher is the essential requirement in order to help their students become proficient in the usage of the symbolic level and achieve a better understanding (Jong and Dreil, 2005).

Investigation of chemistry evaluation anxiety among science stream students in urban and rural schools

The six construct items of chemistry evaluation anxiety that were notably selected by the science stream students in articulating their anxiety towards chemistry evaluation anxiety were: anxiety when performing a chemistry test, anxiety when waiting for chemistry test marks, anxiety when sitting for a chemistry final examination, anxiety when submitting difficult chemistry homework within a particular time, anxiety when being observed by teachers in conducting an experiment in the chemistry laboratory, and anxiety when being evaluated by the chemistry teacher in solving a chemistry problem in front of the class. Similar findings were reported by Eddy The finding is also supported by the results reported by Rooney and Woods who found that most students generally tended to perceive different situations of anxiety during evaluations in terms of quiz, test or general examination. Anxiety about chemistry evaluation make the students perform more poorly than they expected and it also caused those anxious students to score lower

The education system in Malaysia for upper secondary school students is still examination-oriented. Science stream students feel pressure when their performance is solely evaluated by summative assessment and this factor contributes to an increase in their anxiety level in the evaluative situation

In the present study, the science stream students in urban and rural schools also apparently indicated that they perceived anxiety when the chemistry teacher evaluated them by asking them to solve a chemistry problem in front of the class. The feeling of fear in an evaluative situation among those science stream students may occur due to the uneasiness and insufficient mental and physical preparation of the students to be evaluated. It was asserted by Ali and that the student who performs poorly in chemistry evaluation may not be less intelligent; rather, the student's performance may be due to the uninhibited anxiety commonly known as test anxiety.

**Investigation of handling chemicals anxiety among science stream students in urban and rural schools**

The science stream students in urban and rural schools were shown to have anxiety about working with unknown chemicals. The findings also indicated that science stream students in urban schools were anxious when they listened to other students' accounts of accidents in the chemistry laboratory. The finding on the level of anxiety about handling chemicals in this study is supported by past studies claiming that students 'perceived anxiety was affected by laboratory activities [8]

**Comparison of chemistry anxiety among science stream students in urban and rural schools background**

MANOVA analysis was used to compare the mean difference of the chemistry anxiety among science stream students in urban and rural schools in Johor Bahru, Malaysia.

The inspection of the mean scores showed that the mean scores of chemistry evaluation anxiety and handling chemicals anxiety reported by science stream students in urban schools were slightly higher than for science stream students in rural schools. However, the mean score of learning chemistry anxiety demonstrated by science stream students in rural schools was marginally higher compared to science students in urban schools.

Overall, learning chemistry anxiety was the most common attribution factor of chemistry anxiety among science stream students in urban and rural schools. Chemistry evaluation anxiety was perceived moderately by the science stream students, while handling chemicals anxiety was the least common attribution factor of chemistry anxiety expressed by the science stream students in urban and rural schools.

The findings in previous research established that chemistry evaluation anxiety was the main attribution factor of chemistry anxiety by students and these findings are in contrast with the finding obtained from this study in which science stream students in urban and rural schools reported higher levels of perceived chemistry learning anxiety compared to chemistry evaluation anxiety or handling chemicals anxiety. On the other hand, the lowest mean score of chemistry anxiety among the science stream

students in both school backgrounds was for handling chemicals which is similar to the findings reported by Eddy Wanda and

Subsequently, thematic analysis was performed based on the qualitative data in order to support the statistical findings. Thematic analysis also helped in elaborating the insufficient information of primary findings and providing a better understanding of this research. The qualitative data on the highly-anxious group of science stream students in urban and rural schools was purposely selected as the source of data in order to perform the thematic analysis for this research. Several themes were generated in regard to learning chemistry, chemistry evaluation and handling chemicals. The main emerging themes included self-perception, anxiety, self-efficacy and stress. The statistical findings and thematic findings also were supported by Spielberger's trait-state anxiety theory that constituted the theoretical framework of this research.

In terms of learning chemistry, the highly-anxious group of science stream students in rural schools perceived stress in learning chemistry. Indeed, it can be presumed that the factor of stress was provoked and pervaded the extent of anxiety among science stream students in rural schools compared to the science stream students in urban schools. According to Spielberger's state-trait theory of anxiety, stress will apparently exist among the students who have high trait anxiety From the study findings it was indicated the students possibly perceived with high situational anxiety related to chemistry learning.

In regard to chemistry evaluation, the highly-anxious science stream students in the urban schools expressed intense anxiety and lower self-efficacy in regard to chemistry evaluation compared to the science stream students in rural schools. There are several reasons for this anxiety to be perceived by science stream students in both school backgrounds including chemistry was perceived as a difficult subject, students were anxious about making mistakes, and the students were anxious about getting a poor result.

Similarly, the students in urban and rural schools also showed that they perceived lower self-efficacy and had negative self-perception towards chemistry evaluation. In regard to self-efficacy, lower self-efficacy can increase the students' level of anxietMoreover, according to Kurbanoglu and self-efficacy has an effect on chemistry anxiety among students. These researchers also claimed that the students with lower self-efficacy in chemistry evaluation tended to perceive anxiety and also have negative self-perception that brings about negative attitudes towards chemistry as well. Students also have negative perceptions towards chemistry such as chemistry being a dangerous subject to learn, that it involves exposure to hazardous chemicals, that it is about the study of explosions, that they will face difficulties in solving numerical problems and understanding the principles of chemistry, memorization of abstract facts and concepts; as a result, students' anxiety towards chemistry learning leads to loss of interest in the sciences). In addition, with respect to trait-state anxiety theory, the students who have high-trait anxiety usually tend to be disappointed by any state of condition or circumstance that poses a threat to their self-esteem and this leads them to have low self-efficacy

On the contrary, the highly-anxious group of science stream students in rural schools in this study mostly demonstrated positive self-perceptions about chemistry evaluation. Positive self-perception is a strong source of support that can avoid the anxiety phenomenon among science stream students in rural schools in Johor Bahru, Malaysia. Based on these findings, the existence of positive self-perception that expressed by the respondents in urban schools was observed to be the supporting factor that explained why the science stream students in urban schools demonstrated a slightly higher mean score of chemistry anxiety in evaluative situation compared to the highly-anxious group of science stream students in rural schools.

In terms of handling chemicals anxiety, the findings demonstrated that the highly-anxious group of science stream students in urban schools seemed to be less anxious compared to the highly-anxious group of science stream students in rural schools. However, the tendency of highly-anxious students in rural schools to be anxious about handling chemicals was clearly demonstrated as an equilibrium response particularly for the theme of anxiety and positive self-perception. This was the reason why the handling chemicals anxiety among science stream students in rural schools was only a little different in terms of the mean score compared to science stream students in urban schools. Additionally, it has been recognized that a lower level of self-efficacy has a high impact on the chemistry laboratory anxiety among students also mentioned the feeling of uneasiness and fear in conducting laboratory works also related to self-efficacy of students and it was contributed to chemistry laboratory anxiety.

In light of the theory, the findings demonstrated that science stream students in urban and rural schools in Johor Bahru experienced state anxiety towards handling chemicals at a low level. State anxiety existed only when the students perceived that they were in a threatening situation when handling chemicals in the laboratory. This is in line with Spielberger's theory, whereby students who had low trait anxiety performed better in the situation that involved a laboratory setting in which their learning outcomes were still within their control.

## V.CONCLUSION

Chemistry curriculum was introduced to Malaysian secondary school students purposely target to provide each student with knowledge and scientific and technological skills and also generating them to be a problem solver and decision maker in term of their daily life which based on scientific attitude and noble values. Nevertheless, Chemistry anxiety will influence the development process of students to be as the competent experts in scientific and technology world in the near future. Chemistry anxiety that existed among science stream students at secondary school level tends to ruins students' performance and tends to cause the low student enrolment in science field at the tertiary level in the future. By far, the findings of this study discovered that chemistry anxiety was existed and perceived by the science stream students in Johor Bahru, Malaysia.

In intention and with warmest hope, the educators and the entire member of society need to aware about the phenomena of anxiety that silently impede a holistic development among the young generations. There are several recommendations that can be used as a guideline for future researchers or particular authorities to enhance and explore more on psychological issues that related to anxiety phenomena that perceived and existed among our society such as teacher training, teaching psychological concepts in school, diagnostic intervention class.

Teacher training in aspect of mental health interventions or learning strategies program for Malaysian teachers can enhance them to develop their awareness to be concern about their students' development particularly in affective aspects. Harmonized interaction between teachers and students can enhance the students' engagement in their learning process without just being silent when they faced anxiety towards learning subject and retard their development progress.

Conceptual programs such as psychology class that specified on understanding of human behaviour can be introduced as part of school curriculum. A psychology class can assist the students to have the opportunity in telling and expressing their feeling about something that they perceived in their learning or life. Teacher will educate the students to have high self-esteem and self-efficacy that can avoid them to perceive high anxiety and can manage anxiety when they perceived it.

A diagnostic class can be used as treatment medium towards anxiety issues that related to students or teachers in the school setting. A student that perceived anxiety can learn on how to decrease and reduce their trait anxiety towards learning effectively. These sorts of recommendations are purposely can be directed as the prominent track in avoiding the undesirable existence of pervasive anxiety or disorder among all members in our society especially our young generation in a school context. Thus, preventive intervention is a must to be developed and implemented in order to evade the general anxiety that unpleasantly pervade to become as anxiety disorder that consequently will impair the quality of life.

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