CHAPTER 2

REVIEW OF RELATED LITERATURE

2.0 Introduction

This chapter will discuss and review the literature related to the present study. It includes the review on the effects of science anxiety, causes of science anxiety, instruments used for measuring science anxiety, and the relationships of science anxiety with science achievement, attitude towards science and gender.

2.1 Effects of Science Anxiety

Science anxiety is believed to have resulted in numerous problems in students' science learning. Various physical and psychological ways that reflect students' science anxiety have been reported by Mallow (1981, cited in Czerniak et al., 1984). Physically, science-anxious students manifest sweaty palms, upset stomachs, muscle tension and rashes. Psychologically, students display tension and nervousness by tapping feet, chewing nails, becoming distracted, and pulling at hair. Once in class, students fear to participate in laboratory activities, hesitate to ask questions, and freeze upon taking a test. It is suggested that students who suffer from science anxiety may be doing well in all their courses, but are so anxious about one or more science courses that they are unable to function effectively in them (Anderson & Clawson, 1992). This difficulty in concentrating on course

material will give rise to panic during examinations and would then lead to poor performance. According to Mallow (1981, cited in Tobias, 1985), science-anxious students will behave as if they are locked into a concrete reasoning stage and are ill-equipped mentally to deal with abstraction whenever they feel nervous in class, even if they have actually grown beyond the concrete reasoning stage.

Mallow (1981, cited in Chiarelott et al., 1987) also claims that science-anxious students will easily become frustrated, deny competence in science, and ultimately dislike and avoid anything scientific.

Another interesting assertion made by Mallow (1981, cited in Czerniak et al.,1984) about science anxiety is that it is reflected by dropping enrolment in science classes. Science-anxious students tend to avoid science classes and fear to enrol in science courses which appear to be the prerequisites to many science careers (Mallow et al., 1982). As a result, science anxiety would act as a career filter that badly affects students' career choices. It will preclude many from seeking a range of interesting and well-paid careers (Greenburg et al., 1982).

2.2 Causes of Science Anxiety

Mallow et al. (1982) had identified the various sources of anxiety that students bring to their science learning. They reported that science anxiety could be caused by irrational thinking or negative self-statements such as "I just don't have a scientific mind" or "If I can't understand this problem, I'll surely fail the course". Such thinking is directed to the worst possible outcome. Students will

cease to try other alternatives to cope with their problems. This will also result in the students' feeling worthless about themselves in their ability to do science. Whoever has such negative thinking will be blocked from mastering the skills needed (Mallow, 1981, cited in Anderson et al., 1992). This will eventually create science anxiety in the students.

Research has revealed that many students considered science in general and physical sciences in particular as "hard" subjects to learn (Tobias, 1985). Science is an abstract, difficult and useless subject to many students (Bouthyette, 1992). Mallow (cited in Tobias, 1985) found the mythology of 'How difficult physics is' permeated the student population in colleges, even among the students with no exposure to the subject during high schools. In a workshop for helping teachers to develop student confidence in physics, it was pointed out that teachers might intentionally or unintentionally convey the idea that physics was a difficult subject (Tobias, 1985). This was likely to happen when the high standards maintained by the department, the rigorous mathematics prerequisites, and the poor grade record of previous classes were described during the opening lectures in physics.

However, Anderson et al. (1992) in their review on several science anxiety studies note that science anxiety is not a response as a result of a lack of confidence, but rather from a lack of framework of prior knowledge to help order new knowledge.

The lack of specific skills needed for learning science may be one of the causes of science anxiety. Mallow et al. (1983) note that some science-anxious

students have rarely been told explicitly that the skills needed for learning science are different from the skills needed to learn other subjects. Tobias (1985) points out that these students fail to understand that problem-solving in physics, for example, is not rarely a test of what has been learned through reading or listening to lectures or a proof of work done, but is, instead, a major technique for learning new material.

Students often relate past experience that give them a negative impression of science (Brown et al., 1989). Among stories that have been told by students is about egotistical science teachers who enjoy intimidating defenceless students. According to Anderson et al. (1992), teachers who use ridicule would erode self esteem of the students and thus create science anxiety among the students.

Mallow et al. (1983) suggest that teaching science at a Piagetian level above the students' cognitive level may contribute to science anxiety. If students at the concrete level are assumed as formal thinkers and taught in a formal way, they would tend to memorise the material which are supposed to be understood by them.

It is also suggested that science-anxious teachers who are teaching science in elementary and secondary schools may contribute to science anxiety among college students (Mallow et al., 1982). In a study conducted by Sinclair and Ryan (1987), it was also found that teacher anxiety significantly influenced the anxiety experiences of the students. They reported that teacher anxiety had effects on both classroom affective climate and the cognitive framework for student learning. However, they also discovered a possibility of a two-way effect : teacher anxiety

reaction could arouse anxiety in students and the anxiety aroused in the students, in turn, could sustain or even increase teacher anxiety.

Parents who perceive that they are never good at science could convey the message that science anxiety is a heredity phenomenon rather than mastery of a body of knowledge and a set of skills (Anderson et al., 1992).

Other possible causes of science anxiety include general stereotyping of scientists portrayed in the media (Mallow, 1981; Mallow et al., 1982). Scientists are often portrayed as mad scientists, the cold researchers or even the absent-minded professors. These stereotypes would lead to a wrong perception about science and those doing science.

2.3 Instruments for Measuring Science Anxiety

The growing concern in science anxiety has resulted in a number of instruments used for measuring science anxiety. All the instruments are in the form of questionnaires with the Likert rating scale. The various instruments are discussed in the following sub-sections.

2.3.1 Questionnaires Used by the Science Anxiety Clinic

In Mallow's (1981, cited in Wynstra, 1991) Science Anxiety Clinic, each college student who first applied to join the clinic was required to fill up a 44-item questionnaire to indicate how anxious the student felt when doing the activities concerned. A total of 30 statements of the questionnaire were about science-related

activities such as "Lighting a bunsen burner in the preparation of an experiment", while the remaining 14 statements were concerned with non-science activities such as "Having a teaching assistant watch you draw in Art Class". The purpose of having such statements in the questionnaire was to ascertain whether the students were specifically anxious about science or whether they had other problems which they needed to deal with in other ways. A five-point Likert scale ranging from "Not at all" to "Very much" was employed for answering this questionnaire. Mallow (1981) did not establish the reliability and validity of this questionnaire because it was not considered as a formal instrument.

2.3.2 The Science Inventory

The Science Inventory was designed by the Natural Science Programme Committee of Michigon Lancing Community College (LCC) to study the symptoms of science anxiety among the science students (Brown et al., 1989). It consisted of three parts. Part A and Part B assessed the discomfort that students might experience in a science course, in which students were required to respond to the statements by indicating their level of agreement or disagreement. Part A addressed the 'Anxiety of Action' which arose from participation in certain science activities, whereas Part B examined the 'Attitude of Anxiety' which a student had, regarding science and doing science. Part C comprised 21 items chosen from content material taught in the natural science courses. It was designed to assess students' basic skills in the Natural Science Courses such as level of writing,

mathematics, graphing and map reading skills which were required in order to be successful in the courses. The population in the study of Brown et al. was very similar to those described in Mallow's (1981) research findings. No information was available on the validity and reliability of the Science Inventory.

2.3.3 The Czerniak Assessment of Science Anxiety (CASA)

Czerniak et al. (1984) developed the Czerniak Assessment of Science Anxiety (CASA) for use in their study of the relationships between science anxiety, science achievement, gender and grade level factors. The study focused on students from grades four through nine. The CASA consisted of 40 statements which were empirically selected to test four areas : testing situation, laboratory/experiment situation, classroom/lecture situation, and science-related activities. Example of the statements were : "Focusing a microscope", "Thinking about a test in science one day before you are about to take it" and "Being called on in science class". All the statements were science-related. Wynstra (1991) remarked that 20 out of the 40 statements were exactly the same or very closely worded to the questionnaire developed by Mallow. The corresponding weight for the responses was 1 for "Very calm", 2 for "Fairly calm", 3 for "Nervous", 4 for "A little nervous", and 5 for "Very Nervous".

The CASA was pilot-tested on 50 students in grades five and seven in the Bowling Green (Ohio) School District. The alpha reliability for this group was computed to be .94. The CASA was then administered in the final form to 532

students in grades four, six, eight and nine. Factor analysis of the CASA indicated the existence of the following four factors in science anxiety (Czerniak et al., 1984) :

i. direct, physical application of science principles,

ii. testing,

iii. performance in front of others while completing science-related tasks, and

iv. general application of scientific principles

Using the CASA, Wynstra and Cummings (1990) investigated the relationship of science anxiety with achievement, test anxiety, year of chemistry taken, and gender on 101 students (45 males and 56 females) in grades ten through twelve in chemistry classes in a public high school in Rockford, Illinois. A six-month test-retest reliability on the CASA was computed to be .69. The internal consistency computed for the test and retest were .93 and .94 respectively.

However, Wynstra (1991) later commented that the CASA was created for younger children and hence was inappropriate for use with high school students. She claimed that the CASA scale was difficult to interpret. Besides, items relating to many possible components of science anxiety for high school students were missing.

2.3.4 The Science Teaching and Science State-trait Anxiety Inventory

Westerback et al. (1992) claim that the measurement of anxiety about science teaching and science learning could be precisely defined by the adapted State-Trait Anxiety Inventory (STAI). The original STAI was developed by Spielberger, Gorsuch and Lushene (1970). It was referred to as Form-X but was modified by Spielberger and his associates into Form-Y which was more reflective of anxiety than depression (Westeback, 1984). Both the Form-X and Form-Y of STAI have two scales : the state anxiety scale that measures state anxiety and the trait anxiety scale that measures trait anxiety.

Westerback (1984) utilized Form-X in her studies conducted in the years 1977 - 1978, 1978 - 1979 and 1979 - 1980 which focused on preservice elementary teachers' anxiety about teaching science, in which she measured only state anxiety. She then used Form-Y in her subsequent study in 1980 - 1981 and measured both state and trait anxiety after having consultation with Spielberger (Westerback et al., 1992).

According to Westerback et al. (1992), the STAI was a well standardized instrument that could be adapted for use in specific situations by simply modifying the title on the state anxiety scale. In the studies of Westerback (1982, 1984) and Westerback et al. (1985, 1990), different titles on the state anxiety scale were used to measure anxiety in different situations. Examples of the titles on the state scale were : "How do you feel about taking this course ?", "How do you feel about teaching science?", "How do you feel about teaching students to identify mineral

and rocks ?", "How do you feel about identifying minerals and rocks ?" and so on. The same title of "How do you feel in general ?" replaced the original title of "Self evaluation Questionnaire" on the trait anxiety scale. However, the original items in both the state anxiety and trait anxiety scales were not altered.

Westerback et al. (1992) renamed the new versions of STAI for measuring anxiety about science teaching as the Science Teaching STAI and for measuring anxiety about science learning as the Science STAI. They claimed that the Science Teaching STAI and Science STAI were reliable and standardized assessment instruments for assessing anxiety about teaching and learning science.

The Science Teaching STAI and Science STAI consisted of the same 40 items as the original STAI items, with 20 items for each scale. Examples of the statements that appeared in the trait anxiety scale were : "I feel satisfied with myself", "I feel like a failure", and "I feel secure". The responses to the statements were scored using a four-point Likert scale : 1 for "Not at all", 2 for "Somewhat", 3 for "Moderately so", and 4 for "Very much so". On the other hand, the state scale comprised statements such as "I feel calm", "I feel nervous", and "I feel self-confident" which required respondents to rate their responses on a four-point Likert scale : 1 for "Almost never ", 2 for "Sometimes", 3 for "Often", and 4 for "Almost always" (Westerback et al., 1990).

The Science Teaching STAI or Science STAI were utilized in the studies of Chiarelott et al. (1986), Davis (1987), Yurkewicz (1988), and Zoller and Ben-Chaim (1988). Chiarelott et al. examined teachers' anxiety as related to science

anxiety of junior high students. Davis examined anxiety among college students of an introductory chemistry lecture course in a mid-western four-year institution. Yurkewicz examined teachers' anxiety in his study of the relationships among teacher behaviours, high school students' science anxiety and success in science. Zoller and Ben-Chaim examined the interactions between examination type, test anxiety and academic achievement among the preservice college science teachers.

However, in the present study, the Science STAI would not be used since the instrument was not specifically related to science and it was used more on samples at higher levels.

2.3.5 The Science Anxiety Inventory (SAI)

The Science Anxiety Inventory (SAI) was developed by Wynstra (1991) to study the high school science anxiety. In the study, she attempted to measure science anxiety and to establish the relationship of science anxiety with a number of variables, such as gender, year in school, test anxiety, achievement in science and mathematics, attitude about science, avoidance of taking science classes, number of science classes already taken, parents' occupations, and amount of time spent on doing activities or experiments in science classrooms. She interviewed the high school science teachers of every discipline (chemistry, physics, biology, and earth science) and students to identify types of activities that produced students' anxiety about science. Based on the information gathered from the interviews, Wynstra created a 49-item questionnaire, the Science Anxiety Inventory

(SAI). Seven possible factors of science anxiety were taken into account in the SAI. The factors were test anxiety, anxiety about laboratory skills, anxiety about science activities that are dangerous, anxiety about science activities that could make one squeamish, math anxiety, communication anxiety, and anxiety about everyday science activities. The SAI items were answered with a five-point Likert scale ranging from "Not at all nervous" to "Very nervous".

The SAI was pilot tested on a sample of 50 junior college and 70 high school students to determine its reliability. Alpha reliability coefficients of the SAI were .95 for the entire sample, .96 for junior college students, and .95 for high school students, indicating that this instrument had high internal consistency. The content validity of the SAI was established by a panel of four expert science teachers, one in each area of chemistry, physics, biology and earth science. Using the SAI, a study was then carried out on a sample involving 656 high school students. Again, using 57 students selected from the subjects of the study, a one-month test-retest reliability was computed to be .92. To establish the construct validity of the SAI, a principal component analysis was performed on the entire sample (N = 656) and on each gender. The results of the principal component analysis produced six factors which were interpreted as 'Danger Anxiety', 'Science Test Anxiety', 'Math and Problem-solving Anxiety', 'Squeamish Anxiety', 'Performance Anxiety' and 'Science Classroom Anxiety'. The principal component analysis on the males indicated the existence of all the factors except for 'Science Classroom Anxiety'. For the females, the analysis showed all the

factors plus one additional factor which was interpreted as anxiety over working with mechanical things (Wynstra,1991).

The alpha reliability coefficient computed for each factor was considerably high, except for 'Science Classroom Anxiety'. These high reliability coefficients suggested that the SAI was a reliable measure of science anxiety. Table 2.1 shows the alpha reliability coefficients of the factors of science anxiety computed for the entire sample (N = 656), males and females.

The original SAI was adapted by Rohana Jantan (1995) to examine the relationship between science anxiety and grade levels in Kuala Lumpur. Her adaptation was based on the 38 items which loaded in the six factors of science anxiety with a loading of at least .50, in that a total of 9 items was loaded on 'Danger Anxiety', 8 items on 'Science Test Anxiety', 7 items on 'Math and Problem Solving Anxiety', 6 items on 'Squeamish Anxiety', 5 items on 'Performance Anxiety', and 3 items on 'Science Classroom Anxiety'. The sample included 360 students randomly selected from four schools in Kuala Lumpur, 120 students for each level of Form One, Form Two and Form Three. Modifications were made to three of the 38 items without changing the nature of the questions designed. The modifications involved changes as shown in Table 2.2.

Table 2.1

Alpha Reliabilities of Science Anxiety Factors

Factor of Science Anxiety	All Respondents	Males	Females
1. Danger Anxiety	.89	.86	.87
2. Science Test Anxiety	.88	.87	.88
3. Math and Problem-solving Anxiety	.84	.82	.85
4. Squeamish Anxiety	.80	.72	.80
5. Performance Anxiety	.77	.75	.78
6. Science Classroom Anxiety	.59	.57	.60

Source : Wynstra (1991), page 98

Table 2.2

Modifications of SAI Items by Rohana Jantan

Original Item	Modified Item
Dissecting a frog for a science class.	Examine a cockroach in a science class.
Following an example of a math problem in a science book that uses terms like 'log' or 'cosine'.	Following an example of a math problem in a science book.
Collecting saliva to examine with a microscope.	Collecting cheek cells to examine with a microscope.

A translated version of the modified SAI was pilot tested on a sample of 45 lower secondary students (15 students for each level) in a one-month test-retest study. The reliability coefficient for each factor was computed using Pearson Product Moment Correlation technique. The reliability coefficient were reported to be .97 for the entire SAI, .68 for 'Danger Anxiety' , .89 for 'Science Test Anxiety', .86 for 'Math and Problem-solving Anxiety', .92 for 'Squeamish Anxiety', .90 for 'Performance Anxiety' and .69 for 'Science Classroom Anxiety'.

This version of the SAI was later adopted by Foo (1996) in her study on gender differences in science anxiety among 160 Form Four students in Penang. A two-week test-retest reliability was established using a group of 30 students prior to her study. The test-retest reliability coefficient were reported to be .92 for the SAI, .86 for 'Danger Anxiety', .83 for 'Science Test Anxiety', .83 for Math and Problem-solving Anxiety', .82 for 'Squeamish Anxiety', and .83 for 'Science Classroom Anxiety'.

For measuring science anxiety of Form Two students in the present study, the researcher would adapt the original SAI once again. This adapted version of SAI would only comprise those items suitable for Form Two students in Malaysian schools. The researcher found that Rohana Jantan's version of SAI was not suitable for use in this study since it still consisted of many unchanged items that were irrelevant to Form Two students. For the purpose of the present study, the researcher would carefully adapt the SAI items. The procedures followed by the researcher in adapting the instruments would be explained in Chapter 3.

2.4 Relationship of Science Anxiety with Science Achievement

Generally, studies in the field of psychology indicate that there is a relationship between anxiety and academic performance, with low anxiety related to high grade and vice versa (Gaudry et al., 1971). In science education, Mallow (1981) claimed that science anxiety was reflected in lower achievement scores. Mallow et al. (1982) who had been working with science-anxious students in the Science Anxiety Clinic, suggested that some degree of anxiety might be helpful in the learning process, but a high level of anxiety impeded optimum performance in tasks such as science learning. They reported that the existence of science anxiety would paralyse the students who, by any measure of intelligence and industriousness, should do well. In the following paragraphs, data from several science anxiety studies outside the Science Anxiety Clinic supported the work of the psychologists and Mallow's assertion in finding an inverse relationship between science anxiety and science achievement.

Czerniak et al. (1984) examined the relationships among gender, grade levels, science anxiety and science achievement. The sample consisted of 532 students of fourth, sixth, eighth and ninth grades in the Bowling Green School District in Ohio. They found significant differences in science achievement in relation to science anxiety. High levels of science anxiety were found correlating with low levels of science achievement scores as measured by the Comprehensive Test of Basic Skills (CTBS). The CTBS was designed to measure the achievement in basic skills commonly found in science curricula.

Yurkewicz (1988) used 1622 science students from 86 secondary classes of ninth through twelfth grades as the sample for his study on the relationship among teacher behaviours, science anxiety and success in science. A questionnaire used in his study included the items from the STAI, the Teacher Anxiety Related Behaviour Assessment (an instrument developed by Yurkewicz) and questions related to student demographics. The results of zero order correlations and multiple regression analysis showed that the students' perception of teacher behaviours was related to their science anxiety and that anxiety was negatively correlated with achievement at $p < .05$.

Westerback et al.(1985) studied the anxiety levels of 51 students in geology courses. At the end of the course, the students were divided into the grade group above (N = 27) and the grade group below (N = 24) the mean (lab grade of 76%). Results for ANOVA of the two groups showed that there was a relationship between achievement as measured by grade and the state anxiety level. Geology students in the higher grade group had a lower anxiety than those in the lower grade group.

However, Chiarelott et al. (1987) reported that the converse link of lower anxiety and higher achievement was somewhat unclear, though the link of high anxiety and lower achievement was shown clearly in their study on the sample of 532 students. Across fourth through ninth grades in their study, the high achievers showed significantly high levels of science anxiety, though the anxiety levels were much higher among the low achievers. They remarked that having a high level of

science anxiety and being a high achiever might result in a lack of enjoyment of science. Based on the findings, they suggested that merely lowering anxiety levels in some populations might not result in the desired increase in achievement scores. They suggested that effort be accompanied by improved instructional learning experiences.

In Wynstra's (1991) study on 657 high school students, the overall science grade average, overall mathematics grade average and the students' latest science grade had small but significant negative correlations with their science anxiety. The correlations were - .23, - .10 and - .18 respectively. These values were significant at $p < .01$. A hierarchical multiple regression computed by her revealed that the science anxiety was able to predict science achievement above the effects of gender and interest in science topics, but accounted for only 4% of the variance. This might indicate that there were other factors besides science anxiety that could predict science achievement. Therefore, similar to the study by Chiarelott et al. (1987), this study implied that simply lowering the anxiety levels was not enough to see a large increase in science achievement.

The preceding literature indicates that there exists a significant negative relationship between science anxiety and science achievement. This is in line with those reported by studies in the psychology field. Most of the researchers such as Czerniak et al. (1984, 1985), Wynstra (1991) and Yurkewicz (1988) found that science anxiety was significantly and negatively correlated with science achievement. However, it was noted by Chiarelott et al. (1987) and Wynstra (1991)

that simply lowering the anxiety levels of students might not be enough to improve their achievement. Chiarelott et al. (1987) noticed that the high achievers in their study also showed significantly high levels of science anxiety, while Wynstra (1991) found small but significant correlation between science anxiety and science achievement. Wynstra concurred with the suggestion of Chiarelott et al. that the efforts of lowering the anxiety levels should be accompanied by improved instructional learning experience.

2.5 Relationship of Science Anxiety with Attitude towards Science

In Wynstra's (1991) study of high school science anxiety, attitudes about science were measured in terms of liking of science classes, interest in science topics, and time spent interacting with science materials. The information was obtained from the responses on three multiple-choice items on the demographic questionnaire designed for the purpose of her study. For each of the items, five choices were given. The students were asked to circle their choice that best described how they felt about science, how interested they were in science topics and how frequent they interacted with science resources such as books, magazines, TV programmes and so on. The results indicated that liking of science classes, interest in science topics, and the amount of time interacting with science materials had small but significant negative correlations with science anxiety. The correlations were - .27, - .25 and - .14 respectively ($p < .001$). Apart from that, a multiple regression indicated that liking of science classes, interest in science

classes and time spent interacting with science materials jointly accounted for 8% of the variance in science anxiety. From these results, she concluded that the students who had positive attitudes about science exhibited lower levels of science anxiety. By lowering science anxiety, students' interest and enjoyment in science might increase and they might spent more time interacting with science materials.

It was also reported that students who had higher-than-average anxiety scores were less interested in science and had less positive attitudes about science (Wynstra et al., 1993).

A relationship between science anxiety and attitude towards teaching science was reported by Westerback (1982). In a study of preservice teacher anxiety about teaching science, she measured attitudes of preservice teachers towards science using the Modified Bratt Attitude Test (M-BAT). The original BAT (Bratt, 1977) was developed to measure both attitude towards teaching and attitude towards teaching science. It was modified by Westerback to measure only the dimension of attitude towards teaching science. Only items related to science teaching in the BAT were selected for the M-BAT.

The findings of the study indicated that positive attitude as measured by the M-BAT correlated with low anxiety level towards teaching science. It was also reported that the preservice teachers' attitude towards teaching science and anxiety about teaching science were changed in a positive direction during a sequence of science content, in that those with reduced anxiety levels tended to have positive attitude.

In a study of science anxiety among elementary students, junior high students and their teachers, Chiarelott et al. (1986) also utilised the M-BAT to measure teachers' anxiety about teaching science. They found that experienced teachers with low anxiety levels about teaching science had positive attitude towards teaching science. This finding was consistent to that reported by Westerback (1982).

In the present study, the researcher would examine the relationship of science anxiety with a single dimension of attitude towards science rather than multidimentional attitudes. It was the interest of this study to find out how the attitude towards science was related to science anxiety. The preceding literature indicates none of the instruments used in the anxiety studies (Chiarelott et al., 1986; Westerback, 1982; Wynstra, 1991) is suitable for the present study. Although the M-BAT used in the studies of Westerback (1982) and Chiarelott et al. (1986) was a unidimentional attitude scale, it could only measure attitude towards teaching science. Moreover, the demographic questionnaire used by Wynstra (1991) was not a standardized instrument. Therefore, the present study would adopt a different instrument for measuring attitude towards science and this instrument would be described in Chapter 3.

The relationship between science anxiety and attitude was probed in different ways using different instruments in the previous studies (Chiarelott et al., 1986; Westerback, 1982; Wynstra, 1991). The findings indicated that science

anxiety and attitude towards science were related in that students with lower anxiety levels tended to have favourable attitude.

2.6 Relationship of Science Anxiety with Gender

Greenburg et al. (1982) reported that women were particularly hampered by science anxiety. They noticed that women comprised a high percentage of clientele in their science anxiety clinic. Science anxiety clinics set up at various institutions also reported that more females than males had applied to participate in the clinical programme (Czerniak et al., 1985).

In a study of science anxiety among elementary students at grades four, six, eight and nine, Czerniak et al. (1984, 1985) revealed that feelings, particularly anxiety toward science and science related topics, were significantly gender related, with females being more anxious than males at every grade level. They found that even the fourth grade females had already displayed more anxiety towards science than the males.

A study by Meissner (1988) on 308 students from grades four, six, ten, and twelve also reported similar findings. The females at each grade level were reported to have significantly higher science anxiety than the males.

Wynstra et al. (1990) carried out a study on ninth through twelfth graders in chemistry classes in a public high school. Using the Czerniak Assessment of Science Anxiety (Czerniak et al., 1984), they discovered that the females in

chemistry classes were significantly more science-anxious than the males. However, they found that there was no significant gender difference in test anxiety.

Later, Wynstra (1991) developed an instrument called the SAI specifically for high school students. She found that females had significantly higher levels of science anxiety than males in the overall level of science anxiety as well as the five factors of science anxiety, namely 'Danger Anxiety', 'Science Test Anxiety', 'Math and Problem-solving Anxiety', 'Squeamish Anxiety' and 'Performance Anxiety'. Significant gender difference was not found in 'Science Classroom Anxiety'.

Mallow (1994) investigated groups of American and Danish students aged 17 years old and above to determine whether science anxiety was related to gender. He discovered that the females in both national groups scored significantly higher on a variety of science anxiety measures than did the males.

Locally, Foo (1996) adopted Rohana's (1995) version of SAI to compare the level of science anxiety and its six factors between 80 male students and 80 female students from Form Four classes from a few schools in Penang. Consistent to Wynstra's (1991) findings, Foo also found that the females had significant higher levels of overall science anxiety and all the factors of science anxiety, except the Science Classroom Anxiety.

To determine the variables that best predict science anxiety, Hensley (1996) carried out an exploratory study on 166 college students in Microbiology and Biology courses at a university. A number of variables examined included gender, course of study, parent background, achievement, test anxiety and attitude

towards science. The findings of this study indicated that the females tended to have more science anxiety than the males.

Although gender differences in science anxiety have been reported in studies on different samples and settings, Westerback et al. (1992) pointed out that for college students, these gender differences were not supported by studies using the Science STAI.

In the study of Westerback (1984), gender differences were not significant for anxiety about taking college earth science and geology courses. Although the females in geology course showed lower anxiety levels and higher achievement than the males, the difference was not significant.

Later, Westerback et al. (1985) also found no significant differences between the male and female students taking college geology courses on anxiety about identifying minerals and rocks. It was also reported that these students did not exhibit science anxiety.

Further, Westerback (1986) examined initial anxiety scores of 778 college students taking required science courses in biology, chemistry, geology, physics and psychology. Gender differences were not found for these students except for those taking psychology where the females significantly scored higher than the males. The study also found that the females taking biology and psychology courses were more anxious than the females in physical sciences.

Davis (1987) also used the Science STAI in his study for college students taking chemistry. He observed significant gender differences in science anxiety at

the beginning of the course, but the significant differences disappeared at the end of the course. Westerback et al. (1992) remarked that success could be a factor in closing the gap, but added that the trend warranted further investigation.

The preceding literature indicated that gender differences in science anxiety were not supported by studies which utilized the Science STAI (Davis, 1987; Westerback, 1986; Westerback et al., 1984, 1985). However, in those studies where significant gender differences in science anxiety were found, females tended to exhibit higher levels of science anxiety than their counterparts (Czerniak et al., 1984, 1985; Hensley, 1996; Mallow, 1994; Meissner ,1988; Rohana Jantan, 1995; Wynstra, 1991; Wynstra et al., 1990). In the studies of Wynstra (1991) and Foo (1996) which employed the SAI, it was found that the females were more anxious in overall level of science anxiety and its five factors, namely 'Danger Anxiety', 'Science Test Anxiety', 'Math and Problem-solving Anxiety', 'Squeamish Anxiety' and 'Performance Anxiety'. Both of these studies found that the gender difference was not significant in 'Science Classroom Anxiety'.

2.7 Relationship of Test Anxiety and Its Associated Variables

Zoller et al. (1988) studied test anxiety among 83 students who were taking a four-year college teaching training programme. They adopted the Hebrew version of STAI - S.H.M.T. (Taichmann & Malinek, 1984) to measure the anxiety level and found a negative correlation between test anxiety and academic achievement. The findings also indicated that test anxiety correlated with the type

of the examination, with a tendency towards somewhat higher anxiety for the females. They found that the most preferred type of examination were those which permitted the use of any supporting materials (i.e., notebooks, textbook and tables) and had unlimited time duration.

In a study conducted by Wynstra et al. (1990) on the relationships of science anxiety with gender, year in chemistry class, achievement and test anxiety, they discovered that there were no significant gender differences in test anxiety, although the female students in high school chemistry classes were significantly more science-anxious than the male students.

Sulaiman Yamin (1988) examined the effects of frequent testing and conventional testing on students' achievement, test anxiety and attitudes towards science. The sample in his study consisted of 278 male and female students taking the first year general chemistry in Universiti Teknologi Malaysia. The findings on test anxiety indicated that the students exposed to frequent testing were able to significantly reduce their test anxiety compared to the students under conventional testing. This study also revealed that frequent testing significantly enhanced achievement in chemistry as compared with conventional testing, but it did not significantly increase the students' attitudes toward science.

The phenomenon of test anxiety among students who studied science had been examined by educators such as Zoller et al. (1988) and Sulaiman Yamin(1988). Both of them also investigated the type of examination which influenced test anxiety and its associated variables such as achievement. Zoller

et al. (1988) found that test anxiety was correlated with achievement and the type of examination, while Sulaiman Yamin (1988) discovered that frequent testing significantly reduced test anxiety and enhance achievement as compared to the conventional testing. In another study, Wynstra et al. (1990) reported that there were no significant gender differences in test anxiety, although the subjects did show significant gender differences in science anxiety.