

## **CHAPTER 1**

### **STATEMENT OF THE PROBLEM**

#### **1.0 Introduction**

Concern with anxiety had been raised since the third millennium B.C., and in ancient Egypt, Greek and Roman, scholars had initiated writing on anxiety (Price, 1986). Yet, it was not until the twentieth century did anxiety emerge as an explicit and pervasive problem. In fact, the twentieth century has been proclaimed as the 'age of anxiety' (Kutash & Schlesinger, 1980). Beginning from 1950, the widespread of anxiety among individuals have been documented in a large number of psychological research (Spielberger, 1966).

Various psychological theories have been postulated to explain the meaning of anxiety. Freud (1924, cited in Spielberger, 1966) was the first person who attempted to do so. He regarded anxiety as "something felt", an unpleasant affective state or condition.

Spielberger (1979, cited in Price, 1986) describes anxiety as "feeling of apprehension, tension, and worry in the presence of threatening stimulus".

Spielberger (1966) uses two types of anxiety to distinguish between anxiety as a transitory state (state anxiety) and anxiety as a relatively stable personality trait (trait anxiety).

May (1950, cited in Spielberger, 1966) claims that anxiety is “ the apprehension cued off by a threat to some value which an individual holds essential to his existence as a personality”. According to him, while the capacity to experience is innate, the particular events which evoke it are largely determined by learning.

The research interest on anxiety within the field of psychology was later extended to other areas. Therefore, different terms such as mathematics anxiety, computer anxiety, test anxiety, writing anxiety, achievement anxiety, or even science anxiety were created for anxieties originating from different situations. For example, mathematics anxiety refers to feelings of anxiety and tension that interfere with the manipulation of numbers and solving of mathematical problems in a wide variety of ordinary life and academic situations (Richardson & Suinn, 1972).

Science anxiety is a rather new construct as compared to mathematics anxiety (Czerniak & Chiarelott, 1984). The research interest in science anxiety only began after the need to reduce students’ science anxiety received attention and recognition. Some of the pioneering work on science anxiety was done by Mallow and Greenburg (1983) who defined science anxiety as a vague or diffuse fear that arose in response to the prospect of learning science. Mallow (1981, cited in Czerniak et al., 1984) also described science anxiety as a general fear or aversion by students and society towards science concepts, scientists, and science-related activities.

Mallow was a professor of physics in the Loyola University of Chicago, while Sharon Greenburg was a therapist in private practice and also a lecturer in the Guidance and Counselling Department in the same university (Greenburg & Mallow, 1982). In 1977, together they established a Science Anxiety Clinic in Loyola University of Chicago. The clinic was intended for the students who referred themselves as science-anxious. It consisted of weekly 1 ½ hour-meetings for seven weeks. Each clinic group comprised 6 to 10 students and was led by a scientist (faculty staff or an advanced graduate student) and a psychologist or counsellor.

In the Science Anxiety Clinic, the students were guided to develop effective science study skills and to acquire psychological techniques for coping with science anxiety (Greenburg et al., 1982). Participants of the clinic were young undergraduates, previously working men and women who returned to study in the university. Among the participants, females outnumbered males.

In 1978, Alvaro (1978, cited in Greenburg et al., 1982) tested the effectiveness of the Science Anxiety Clinic in reducing science anxiety. She compared a group of students who joined the clinic with a group of students who had applied for the clinic but whose schedules precluded their participation. Alvaro administered pre-test and post-test that measured science anxiety, test anxiety, mathematics anxiety, state-trait anxiety, and achievement anxiety. Significant reductions in all anxieties were found except for test anxiety. These

findings indicated that the clinic techniques did effectively reduce science anxiety and other forms of anxiety.

Alvaro's study on the effectiveness of the Science Anxiety Clinic was reported by Mallow (1981) in his book "Science Anxiety : Fear of Science and How to Overcome It", in which he extensively examined science anxiety and its effect on science learning. Later, Mallow also published several articles about his work on science anxiety (Greenburg et al., 1982; Mallow, 1991, 1994; Mallow & Greenburg, 1982, 1983). Eventually, Mallow's work has become the major reference in a number of science anxiety research (Brown & Cranson, 1989; Chiarelott & Czerniak, 1987; Czerniak et al., 1984; Foo, 1996; Rohana Jantan, 1995; Wynstra, 1991). The success of the Science Anxiety Clinic also contributed to the concern of educators on the importance of overcoming science anxiety. Hundreds of high schools and colleges in the United States of America requested information from the Science Anxiety Clinic on how they could start their own clinics for their students who had similar anxiety (Mallow, 1981, cited in Rohana Jantan, 1995).

Although the pioneering work of Mallow et al. (1982, 1983) generated more research on science anxiety, the idea of science anxiety was rather general. The construct was not factor analyzed. It was later that other researchers came out with more specific and concrete models of science anxiety.

Czerniak et al. (1984) were among the researchers who had attempted to create a more definite psychometric construct of science anxiety. They conducted a



study to determine the levels of science anxiety in relation to grade levels, sex and science achievement among students in grades four, six, eight and nine. Factor analysis carried out in the study indicated that there were four factors of science anxiety, namely direct, physical application of science principles; tests; performance in front of others while completing science-related tasks and general application of scientific principles. This construct of anxiety, however, was targeted for the students ranging from primary grades to high school.

Later, Wynstra (1991) examined science anxiety of high school students using the Science Anxiety Inventory (SAI) developed by herself. A principal components analysis carried out by her on the entire sample ( $N = 656$ ) showed the existence of six factors which were interpreted as 'Danger Anxiety', 'Science Test Anxiety', 'Math and Problem-solving Anxiety', 'Squeamish Anxiety', 'Performance Anxiety' and 'Science Classroom Anxiety'.

From the studies of Czerniak et al. (1984) and Wynstra (1991), it can be seen that science anxiety is a construct which could vary for different age groups of targeted population.

Parallel to the efforts of Mallow was the research work done by another science educator, Westerback. However, Westerback did not use the term 'science anxiety' in her studies. Her interest was more on preservice teachers (Westerback, 1982; Westerback, 1984; Westerback, Gonzalez & Primavera, 1984, 1985; Westerback & Long, 1990). She began to study anxiety about teaching science in preservice teachers in 1977 when there were then no such studies being carried out.

The anxiety about teaching science and learning science was based on a different construct of the state and trait anxiety, which was generally used by anxiety studies in psychology. State anxiety referred to anxiety about specific situations which could be influenced by training, whereas trait anxiety was defined as individual differences in anxiety proneness which was more stable (Westerback et al., 1990). Initially, she measured only state anxiety in her studies conducted from the year 1977 to 1979. But later she used both the state and trait anxiety after finding out that the trait anxiety was also important as the measurement would allow researchers to gauge whether the subjects were anxious about what they were being measured or were just generally anxious (Westerback & Primavera, 1992).

Using a multidimensional construct of science anxiety, researchers attempted to relate science anxiety and several variables in order to probe the effects of science anxiety on science-anxious students. In the study of Czerniak et al. (1984), it was reported that science anxiety was negatively correlated with science achievement. Wynstra (1991) reported that science anxiety had negative relationships with a number of variables such as achievement in science and mathematics, attitudes about science, the total number of science classes that the students planned on taking through high school and the number of science classes already taken by the students. She also discovered that science anxiety and career preferences were related. The students who were planning on majoring in science were found to have lower levels of science anxiety than those who were not.

## 1.1 Background of the Study

Although strong research evidence has shown that science anxiety does exist in some individuals (Mallow, 1981), there is limited literature on science anxiety, especially in Malaysia. As far as the present researcher could detect, only two studies concerning science anxiety have been carried out in Malaysia (Foo, 1996; Rohana Jantan, 1995). Sulaiman Yamin (1988) claims that in general, anxiety in science is high and this is especially true among Malaysian students. Therefore, it would be interesting to investigate science anxiety among the Malaysian students.

In the past few years, there has been a steep decline of enrolment into the science stream in Malaysian secondary schools and in the science courses in universities. The statistics from the Ministry of Education of Malaysia indicated that the overall science stream enrolment in Form Four fluctuated in the period from 1981 to 1986 when it was at a maximum of 99,084 (Sharifah Maimunah Zin & Lewin, 1991). Since then there has been a continuous decline both as a proportion of total enrolment and in absolute number. In the year 1996, for example, only 20% of the students who completed their PMR examination (Lower Secondary Assessment) opted for the science stream when compared to 40% in the year 1995 ("More Interesting," 1996). This trend has become a great concern in Malaysia. To establish a scientific and progressive society by the year 2020 as envisaged by the Prime Minister, Dr Seri Mahathir Mohamad, science education plays an important role to meet the increased demand for skilled technical

manpower (Mahathir, 1991). Mallow (1981, cited in Czerniak et al., 1984) claims that science anxiety is reflected by dropping enrolment in science classes. As the current trend of science enrolment is not promising, research on science anxiety is needed in Malaysia. It would be of interest to find out to what extent our students feel anxious in learning science so that measures could be taken to reduce science anxiety and to promote science learning.

Czerniak and Chiarelott (1985) found that science anxiety developed among students somewhere between the elementary and the high school levels. However, the literature which documents science anxiety studies focuses mainly on pre-service, in-service science teachers and college students (Brown et al., 1989; Mallow, 1981; Westerback, 1982, 1984; Westerback et al., 1985; 1990). Only a few researchers have studied science anxiety at lower level (Chiarelott et al., 1987; Foo, 1996; Rohana Jantan, 1995; Wynstra, 1991). More science anxiety research needs to be carried out at lower level. In Malaysia, a study done by Rohana Jantan (1995) found that Form Two students exhibited a higher level of anxiety toward science, followed by Form One and Form Three students in descending order.

Wynstra (1991) reported that science anxiety was not unidimensional, but was composed of many factors. She found that there were actually six factors of science anxiety, namely 'Danger Anxiety', 'Science Test Anxiety', 'Math and Problem-solving Anxiety', 'Squeamish Anxiety', 'Performance Anxiety' and 'Science Classroom Anxiety'. An instrument entitled the Science Anxiety Inventory (SAI) was developed by her specifically to measure science anxiety of

high school students. This study would make use of an adapted version of the SAI to investigate science anxiety levels of Form Two students and to identify the top ten science-related activities that contributed to their anxiety.

The literature in psychology indicates a consistent negative relationship between anxiety and academic achievement (Gaudry & Spielberger, 1971). Low anxiety appears to be related to high grades and vice-versa. Similarly, in the studies related to mathematics anxiety, Betz (1978), Clute (1984) and Reyes (1984) had consistently found a negative relationship between mathematics anxiety and mathematics achievement. Studies by the science educators such as Chiarelott et al. (1987), Westerback et al. (1985) and Wynstra (1991) also found a negative relationship between science anxiety and science achievement. It should be noted that research on the relationship of science anxiety with science achievement has not been carried out in Malaysia. Therefore, it was one of the aims of this study to look into this relationship.

Little literature is available concerning the relationship of science anxiety with attitude towards science. Previous studies have attempted to relate attitude towards science to variables such as achievement, stress, rewards, reinforcement, testing, motivation, grade levels, teachers and so on (Wareing, 1990). Most of the studies on attitude were documented during the 1960's and 1970's, whereas science anxiety has only become a great concern since 1980's. As far as the researcher could determine, very few studies (Chiarelott & Czerniak, 1986; Westerback, 1982; Westerback et al., 1990; Wynstra, 1991) have directed to study the

relationship of these two variables. A study to explore the relationship of these two variables would contribute to the existing literature in the field of science anxiety research especially in the Malaysian context.

Gender differences are always of great interest in educational research. Research has shown that females take fewer science classes and their career orientation to science related professions differs from the males (Peterson, Kauchak & Yaakobi, 1980). Generally, the males show a more positive attitude towards science and have a higher achievement in science than the females (Cannon & Simpson, 1985). Bowyer (cited in Kahle & Lakes, 1983) describes that boys in school are valued for thinking logically, independently, with self-confidence and appropriate degree of risking. Girls, however, are valued for their emotional expressiveness, sensitivity to others, dependency, and subjective thinking. Although some studies found no significant relationship between science anxiety and gender (Westerback et al., 1984, 1985, 1990, 1992), significant gender differences in science anxiety, with females having higher level of science anxiety, were reported in the studies by Czerniak et al. (1984, 1985), Foo (1996), Mallow(1994), Meissner (1988) and Wynstra (1991). The present study would also examine whether there were gender differences in science anxiety.

## **1.2 Research Questions**

The purpose of this study was to investigate science anxiety among Form Two students and to examine the relationship between science anxiety and three

selected variables, namely science achievement, attitude towards science, and gender. The science anxiety would be measured by the Adapted Science Anxiety Inventory (SAI-A) which comprised six dimensions, namely 'Danger Anxiety', 'Science Test Anxiety', 'Math and Problem-solving Anxiety', 'Squeamish Anxiety', 'Performance Anxiety' and 'Science Classroom Anxiety'.

Based on the students' science anxiety scores on the SAI-A and the six SAI-A dimensions, this study aimed to answer the following research questions :

1. What were the science anxiety levels of the Form Two students with respect to the SAI-A dimensions ?
2. Which were the top ten anxiety-contributing activities for the Form Two students ?
3. Did the high and the low anxiety groups differ significantly in their science achievement ?
4. Did the high and the low anxiety groups differ significantly in their attitude towards science ?
5. Were there any significant gender differences in science anxiety of the Form Two students ?

### **1.3 Definition of Terms**

In this study, the term 'dimension' was used instead of 'factor' which was used in Foo's (1996) and Wynstra's (1991) studies. The definitions of science anxiety and its dimensions were adapted from the descriptions given by Wynstra

and Cummings (1993). Other terms used in this study were operationally defined by the present researcher.

### **Science Anxiety**

This refers to the anxiety among students towards science-related activities.

It is multidimensional and composed of the following six dimensions :

Danger Anxiety

Science Test Anxiety

Math and Problem-solving Anxiety

Squeamish Anxiety

Performance Anxiety

Science Classroom Anxiety

Operationally, science anxiety is defined as the science anxiety score as measured by the Adapted Science Anxiety Inventory (SAI-A).

### **Danger Anxiety**

This refers to the anxiety over doing things in the science class that might be dangerous such as using poisonous, hazardous or flammable chemicals, and lighting a bunsen burner and such other dangerous activities.

### **Science Test Anxiety**

This refers to the anxiety over taking science tests, final examinations, and answering different kinds of test questions.



**Math and Problem-solving Anxiety**

This refers to the anxiety over math and problem-solving in science which includes working out word problems and dealing with graphs and data tables.

**Squeamish Anxiety**

This refers to the anxiety over activities that could make one squeamish such as looking at a preserved biological specimen in a bottle, and collecting saliva or cockroaches for use in experiments.

**Performance Anxiety**

This refers to the anxiety about performing and communicating in the science class such as doing science projects and explaining the results to the class, being asked a question in class and having watched by the teacher when they carry out a laboratory procedure.

**Science Classroom Anxiety**

This refers to the anxiety about being in the classroom and doing activities which include listening to a lesson, taking notes, and answering questions for science homework.

**Science Achievement**

This refers to the students' science achievement scores as measured by the Science Achievement Test (SAT). The science achievement includes the acquisition of knowledge, understanding, as well as the applications of concepts and theories covered by the Form Two science chapters.

### **Attitude towards Science**

This refers to the degree to which students like or enjoy science as a subject in school as reflected by the scores on the Attitude towards Science in School Assessment (ATSSA).

### **KBSM Science**

This refers to the 'Integrated Secondary School Science Curriculum', a core subject compulsory for secondary school students. The science content is arranged thematically and consists of the integration of scientific knowledge and its application, scientific skills and good moral values.

### **Anxiety-contributing Activity**

This refers to the activities which contribute to the anxiety of learning science.

### **High Anxiety Group**

This refers to the top 30% of students according to their science anxiety scores.

### **Low Anxiety Group**

This refers to the lowest 30% of students according to their science anxiety scores.

## **1.4 Assumptions of the Study**

In this study it was assumed that science anxiety could be measured by the SAI-A, while science achievement and attitude towards science could be measured

by the SAT and the ATSSA respectively. The SAI-A was assumed to have the same factorial validity as the SAI as obtained by Rohana Jantan (1995) and Wynstra (1996) in their studies. This meant that the factors found by Rohana Jantan (1995) and Wynstra (1996) in SAI were the same as SAI-A in the present study. It was also assumed that both the SAI-A and ATSSA had been accurately translated from English to Bahasa Melayu.

The students' science achievement and attitude towards science were assumed as partly contributed by their science anxiety. Both the science achievement and attitude towards science were treated as the dependent variables with science anxiety acting as the independent variable. On the other hand, in the relationship of science anxiety with gender, the science anxiety was identified as the dependent variable with gender as the independent variable. The variables involved in this study are shown in Table 1.1.

**Table 1.1**

**Variables Involved in the Study**

Relationship of Variables	Independent Variable	Dependent Variable
Science Anxiety with Science Achievement	Science Anxiety	Science Achievement
Science Anxiety with Attitude towards Science	Science Anxiety	Attitude towards Science
Science Anxiety with Gender	Gender	Science Anxiety

### **1.5 Significance of the Study**

This study was one of the few studies carried out in Malaysia on science anxiety and its relationships with other variables. It was hoped that the findings of this study would be useful to educators, especially the teachers who were teaching in the target school.

This study would provide valuable information regarding the anxiety levels of Form Two students as well as the top ten anxiety-contributing activities. The data could be used as a basis by teachers to identify steps and strategies for reducing students' anxiety and thereby providing better learning situations for the students.

This study was also significant in the sense that it would present data on the relationships of science anxiety with science achievement and attitude towards science which was currently not available in Malaysia. This information would help educators to shed some lights on students' science anxiety with regard to science achievement and attitude towards science. If science achievement was negatively related to science anxiety, then the students' science achievement could be enhanced by reducing their science anxiety. If the same also happened to science anxiety and attitude towards science, then positive attitude towards science should be developed by reducing science anxiety. Specific measures could be introduced to reduce their anxiety pertaining to the six dimensions of science anxiety.

This study has also examined whether science anxiety was gender-related. The findings would help to find out whether there was a specific gender group with a higher level of science anxiety that needed to be taken into account in overcoming science anxiety.

### **1.6 Limitations of the Study**

This study was limited to a sample of Form Two students from a selected secondary school in the Kuala Pilah Town in the State of Negeri Sembilan. Hence, the results could not be generalized to the population of Form Two students in the whole of Malaysia.

This study was limited to only the variables of science anxiety, science achievement, attitude towards science and gender. Other variables such as grade level, socio-economic status and ethnicity were beyond the scope of the study.

This study was also limited to the extent that students responded honestly to the items on the SAI-A and ATSSA and that they clearly understood the items.