CHAPTER 5

CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS FOR FUTURE WORK

5.0 Introduction

The main purpose of this study was to investigate the science anxiety levels of the Form Two students and to determine whether there were any significant relationships between science anxiety and the three selected variables of science achievement, attitude towards science and gender. Attempts were also made to find out the top ten anxiety-contributing activities of the students.

Science anxiety of the students was measured by the SAI-A (Adapted Science Anxiety Inventory). This instrument measured the six dimensions of science anxiety, namely 'Danger Anxiety', 'Science Test Anxiety', 'Math and Problem-solving Anxiety', 'Squeamish Anxiety', 'Performance Anxiety' and 'Science Classroom Anxiety'.

Other instruments involved in this study were the SAT and the ATSSA. The SAT was used to measure the students' achievement in science whereas the ATSSA was to measure a single dimension of students' attitude towards science in school. The SAT was constructed by the researcher, and the ATSSA was a standardized instrument developed by Germann (1988).

The subjects of this study comprised 148 (70 male and 78 female) Form Two students from a semi-residential secondary school which was located in Kuala Pilah Town in the State of Negeri Sembilan.

5.1 Conclusions

The findings of this study are presented in the following sub-sections.

5.1.1 Science Anxiety Levels

The Form Two students showed slight anxiety in all the dimensions except for 'Danger Anxiety' and 'Science Classroom Anxiety'. They had moderate anxiety in 'Danger Anxiety', but showed no anxiety at all in 'Science Classroom Anxiety'.

5.1.2 Top Ten Anxiety-contributing Activities for Students

The rank order of the top ten anxiety-contributing activities for the Form Two Student are as follows :

Rank Order	Activity	Dimension of Science Anxiety
1	Working with chemicals that are poisonous.	Danger Anxiety
2	Using flammable chemicals.	Danger Anxiety
3	Taking the final examination for a science class.	Science Test Anxiety
4	Using expensive glass apparatus in the laboratory .	Danger Anxiety
5	Using hazardous chemicals, like acids in the laboratory.	Danger Anxiety
6	Taking a science Test.	Science Test Anxiety
7	Working with an electrical power supply.	Danger Anxiety
8	Studying for a science test.	Science Test Anxiety
9	Heating something with a bunsen burner.	Danger Anxiety
9	Studying a fresh specimen of a cow's eye in the science class.	Squeamish Anxiety

Out of the top ten anxiety-contributing activities, six activities were from the dimension 'Danger Anxiety'. These comprised respectively the first, second, fourth, fifth, seventh and ninth most anxiety-contributing activities. A total of three activities from the dimension 'Science Test Anxiety' were identified as the third, sixth and eighth most anxiety-contributing activities. Only one activity from the dimension 'Squeamish Anxiety' appeared as the ninth most anxiety-

contributing activity, sharing the same rank order with an activity from the dimension 'Danger Anxiety'.

In descending order, the top four anxiety-contributing activities for the Form Two students were :

Working with chemicals that are poisonous,

Using flammable chemicals,

Taking the final examination for a science class, and

Using expensive glass apparatus in the laboratory .

These activities were the same top four anxiety-contributing activities for the male and for the female students. Three out of these activities were from the dimension 'Danger Anxiety' and the remaining one came from the dimension 'Science Test Anxiety'.

The fifth most anxiety-contributing activity for the students was 'Using hazardous chemicals, like acids in the laboratory'. This activity was also the fifth most anxiety-contributing activity for the male students as well as for the female students. However, the activity 'Collecting cockroaches to use in an experiment' was also the fifth most anxiety-contributing activity for the female students.

The sixth most anxiety-contributing activity for the Form Two students was 'Taking a science Test'. This activity was the sixth most anxiety-contributing activity for the male students and it was the eighth most anxiety-contributing activity for the female students.

The seventh most anxiety-contributing activity for the Form Two students was 'Working with an electrical power supply'. For the male students, this activity was also the seventh most anxiety-contributing activity, sharing the same rank with the activity 'Collecting cheek cells to be observed with an microscope'. As for the female students, the activity 'Working with an electrical power supply' was not among the top ten anxiety-contributing activities.

The eighth most anxiety-contributing activity for the Form Two students was 'Studying for a science test'. This activity was also the ninth most anxiety-contributing activity for the female students, but it was not among the top ten anxiety-contributing activities for the male students.

There were two activities sharing the same rank as the ninth most anxiety-contributing activity. The activities were 'Heating something with a bunsen burner' and 'Studying a fresh specimen of a cow's eye in the science class'. The activity 'Heating something with a bunsen burner' was the tenth most anxiety-contributing activity for the female students, but it was not among the top ten anxiety-contributing activities for the male students. On the other hand, the activity 'Studying a fresh specimen of a cow's eye in the science class' was the ninth most anxiety-contributing activity for the male students, sharing the same rank with the activity 'Having my science teacher ask me a question in class'. However, the activity 'Studying a fresh specimen of a cow's eye in the science

class' was not among the top ten anxiety-contributing activities for the female students.

The activity 'Collecting cockroaches to use in an experiment' from the dimension 'Squeamish Anxiety' was the fifth most anxiety-contributing activity for the female students, but it was not one among the top ten anxiety-contributing activities for the male students and also for all the subjects taken as a whole.

The activity 'Collecting cheek cells to be observed with a microscope' was the seventh most anxiety-contributing activity for the male students. However, it was not one of the top ten anxiety-contributing activities for the female students as well as for all the subjects taken as a whole.

Although the activity 'Having my science teacher ask me a question in class' from the dimension 'Performance Anxiety' was the ninth most anxiety-contributing activity for the male students, it was interesting to note that this activity was not one of the top ten anxiety-contributing activities for the female students as well as for all the subjects involved in this study. This might indicate that the male students were particularly more anxious about their performance in class when being asked questions by their science teachers.

5.1.3 Relationship of Science Anxiety with Science Achievement

There were significant differences in science achievement between the high and low anxiety groups for the overall science anxiety and also for the

dimensions 'Danger Anxiety', 'Math and Problem-solving Anxiety', 'Squeamish Anxiety' and 'Performance Anxiety'. In all the cases, the high anxiety group showed significantly lower achievement in science than the low anxiety group. Therefore, it could be concluded that the students in the high anxiety group for these dimensions tended to have low achievement in science when compared to those in the low anxiety group.

However, the high and low anxiety groups for the dimensions 'Science Test Anxiety' and 'Science Classroom Anxiety' did not differ significantly in their science achievement.

5.1.4 Relationship of Science Anxiety with Attitude towards Science

There were significant differences in attitude towards science between the high and low anxiety groups for the overall science anxiety and also the dimension 'Danger Anxiety'. In every case where a significant difference was found, the high anxiety group showed a less positive attitude towards science as compared to the low anxiety group.

For all the dimensions of science anxiety except the 'Danger Anxiety', the high and low anxiety groups did not differ significantly in their attitude towards science.

5.1.5 Relationship of Science Anxiety with Gender

The female students showed significantly higher anxiety levels than the male students for the overall science anxiety as well as for the dimensions 'Danger Anxiety', 'Science Test Anxiety', 'Math and Problem-solving Anxiety', 'Squeamish Anxiety' and 'Performance Anxiety'.

No significant gender difference was found for the dimension 'Science Classroom Anxiety'.

5.2 Implications

Some implications could be drawn from this study. These implications are useful to educators, especially the science teachers teaching in the school where this study was conducted. The following sub-sections discuss the implications with regard to the research questions.

5.2.1 Top Ten Anxiety-Contributing Activities for Students

The findings on the top ten anxiety-contributing activities showed that most of the activities were related to the danger aspects in the science laboratory, especially the activities involving the use of chemicals and equipment (for details, refer to page 115). These activities were actually hands-on activities through which the students were supposed to explore science concepts and theories. If 'Danger Anxiety' among the students towards these particular science-related

activities could be minimised or eradicated, it would provide the students with anxiety-free situations where the students could learn science without feeling worried.

This study also showed that many anxiety-contributing activities for the students were related to 'Science Test Anxiety'. The findings indicated that a final examination caused more anxiety than a science test, while 'Taking a science test' caused more anxiety than 'Studying for a science test'. These findings should be taken into account when planning strategies to reduce the students' science test anxiety.

5.2.2 Relationship of Science Anxiety with Science Achievement

As this study found a significant difference in science achievement between the high and low anxiety groups for overall science anxiety, the students in the high anxiety group were more likely to obtain better science achievement if their science anxiety could be reduced or overcome. Therefore, measures should be taken to reduce science anxiety of these students.

5.2.3 Relationship of Science Anxiety with Attitude towards Science

The findings of the relationship of science anxiety with attitude towards science indicated that the high and low anxiety groups differed significantly in their attitude towards science. The implication of this was that the students in the

high anxiety group would have a more favourable attitude towards science if their science anxiety levels could be lowered.

5.2.4 Relationship of Science Anxiety with Gender

The findings of this study revealed that the female students showed a higher level of science anxiety. Thus, they need more attention than their male counterparts. Teachers should eradicate the myth that males were naturally better than females in math, science and technology (Reyes & Padilla, 1985). Measures should be taken to reduce the female students' science anxiety through encouraging them to be actively involved in science classes and helping them to gain more confidence in doing science.

According to Mallow et al. (1982), science-anxious teachers would contribute to science anxiety among students. In the study of Sinclair et al. (1987), it was also found that teacher anxiety significantly influenced the anxiety experiences of the students. Teachers, particularly the female science teachers, could act as role models and not be afraid to handle any science experiments involving the danger and squeamish aspects of science experiments. The lack of female role models had also been suggested as one of the factors that contributed to female students' lack of participation in math and science (Fear-Fenn & Kapostasy, 1992). Thus, it would be useful if the female science teachers could be the role models for the female students in science classes.

5.2.5 Specific Measures to Reduce Science Anxiety

To reduce the 'Danger Anxiety' of the students, science classes, syllabus and textbooks should place emphasis on the acquisition of knowledge and practical skills concerning the safety hazards and safety precautions in the science laboratory. By training students to follow proper safety precautions, they would be able to deal with the danger aspects more confidently. According to Swami and Singh (1985), when proper equipment was not available for every student, or adequate supervision in the laboratory was not available, teachers should find alternatives such as trying non-hazardous substitute chemicals, perform a demonstration with extra care, or even abandon the exercise if they could not make the condition safe enough. This was to ensure student safety and to avoid any accidents that might create anxiety and be remembered by the students as a bad experience.

In constructing a test or examination, if teachers could place the emphasis on the understanding of concepts rather than rote memorization, science test anxiety of the students could probably be reduced. In a study carried out by Zoller et al. (1988), it was found that the students preferred examinations which emphasized on understanding and analysis rather than knowing and 'remembering'. Also teachers should not rely merely on the final examination to assess students' achievement. Class project, quizzes or homework could be considered as part of the assessment. This had been practised before in a college

in which a science course was developed for the underprepared and science-anxious students (Brown et al., 1989).

One cannot avoid from sitting for tests and examinations. Therefore, teachers should help students to master skills involved in studying science as a way to tackle their science test anxiety. Examples of the skills are those needed for reading science material, approaching word problems, taking notes and doing laboratory experiments (Mallow et al., 1982). Furthermore, teachers should also encourage students to apply these study skills together with good study habits such as having a study schedule and revise notes consistently (Liew, 1996). Teachers should also play their part to ensure good teaching. They should teach according to students' cognitive levels so that the students could understand (Mallow et al., 1983). When teaching the difficult science concepts, concept mapping could be used as an instructional strategy. The concept mapping strategy was reported to be effective in reducing student' anxiety towards the learning of biology and enhanced biology achievement (Jegede, Alaiyemola & Okebukola, 1990).

To reduce the 'Math and Problem-solving Anxiety', students could be taught how to identify types of problems they were supposed to deal with. The process of pattern recognition and initial description of a problem is an essential part of the solution process (Ryan, 1989). As soon as students could recognize the pattern of the problem, they would be able to set up and solve the problem correctly.

Students' 'Squeamish anxiety' could be reduced if they could be taught to accept the world of science which is closely associated with all things (living and non-living) around us. Students should be taught and trained to accept that dealing with cockroaches, saliva or the specimen of a fresh cow's eye are parts of learning science.

To reduce students' performance anxiety, teacher-student relationship as well as the classroom interactions must be improved. Teachers should train students to speak up in science classes and never make fun of their questions or answers. Students could also be encouraged to form cooperative study groups because cooperative process encourages the verbalization of problem-solving and motivates interaction and networking among group members (Keyser, 1993).

5.3 Recommendations for Future Work

This study was carried out among the Form Two students from a semi-residential and a co-educational secondary school. To investigate whether the findings of this study are generalizable, replication of the present study could be carried out on a bigger sample involving more schools. This would also enable researchers to determine whether the present findings would still be applicable to a bigger sample. Moreover, with a bigger sample, factor analysis for the dimensions of science anxiety as measured by the SAI-A could be established for Malaysian sample.

Besides the variables involved in this study, there are other variables such as mathematics anxiety and locus of control that might be related to science anxiety. Research could be carried out to get insight of how these variables relate to science anxiety of Malaysian students.

Finally, since all the science anxiety studies found in Malaysia focused on secondary school students, further investigation should be carried out on students from higher institutions such as colleges, teachers training colleges and universities. These targeted groups at the higher institutions have been used in foreign studies, but they have not been studied in Malaysia.