CHAPTER V
FINDINGS, DISCUSSION, RECOMMENDATIONS AND SUGGESTIONS

5.1 INTRODUCTION

After processing the data, obtaining and interpreting the results in previous chapter, the findings have been discussed in present chapter. In this chapter, the results are discussed to show how these findings are concurrent with some of the studies already conducted in metacognition. Keeping the major findings in view, the educational implications and recommendations have been given. Suggestions have been given for the further research. This chapter therefore is devoted to focusing the findings, discussion, recommendations and suggestions for further studies.

5.2 FINDINGS OF THE STUDY

The following are the findings that were obtained by testing the hypotheses:

i. It was found that there was no significant difference exists among three groups. Hence, the three groups are homogeneous in metacognitive awareness, attitude towards learning biology and home environment.

ii. It was found that there was no significant difference exists among three groups. Hence, the three groups are homogeneous based on the performance in pre-test.

iii. It was found that there was significant difference exists among control group, IBLMG and CLMG. When the post-test mean scores are compared, IBLMG students are better than the control group students. CLMG students are better than the control group students, when comparing the post-test mean scores of control group students and CLMG students. CLMG students are better than the IBLMG students, when comparing the post-test mean score of IBLMG students and CLMG students.
iv. Control group, IBLMG and CLMG students differ significantly in gain scores. When comparing the gain score of IBLMG students and control group students, IBLMG students are better than the control group students. When comparing the gain score of CLMG students and control group students, CLMG students are better than the control group students. When comparing the gain score of IBLMG students and CLMG students, CLMG students are found to be better than IBLMG students.

When comparing the gain scores among three groups, CLMG students are found to be the best among the three groups.

v. a. Control group, IBLMG and CLMG students differ significantly in mean gain score of knowledge objective. When comparing the mean gain score of knowledge objective, IBLMG students are better than the control group students. When comparing the gain score of knowledge objective CLMG students are better than the control group students.

When comparing the gain scores of knowledge objective of three groups, CLMG students are found to be the best among the three groups.

b. Control group, IBLMG and CLMG students differ significantly in mean gain score of understanding objective. When comparing the mean gain score of understanding objective, IBLMG students are better than the control group students. When comparing the gain score of understanding objective CLMG students are better than the control group students.

When comparing the gain scores of understanding objective of three groups, CLMG students are found to be the best among the three groups.

c. Control group, IBLMG and CLMG students differ significantly in mean gain score of application objective. When comparing the mean gain score of
application objective, IBLMG students are better than the control group students. When comparing the gain score of application objective CLMG students are better than the control group students.

When comparing the gain scores of application objective of three groups, CLMG students are found to be the best among the three groups.

vi. Control group, IBLMG and CLMG students differ significantly in retention test scores. When comparing the retention test score of IBLMG students and control group students, IBLMG students are better than the control group students. When comparing the retention test score of CLMG students and control group students, CLMG students are better than the control group students. When comparing the retention test score of IBLMG students and CLMG students, CLMG students are found to be better than IBLMG students.

When comparing the retention test scores among three groups, CLMG students are found to be the best among the three groups.

vii. Home environment and attitude towards learning biology of control group, IBLMG and CLMG are correlated significantly.

viii. Home environment and metacognitive awareness of control group, IBLMG and CLMG are not correlated significantly.

ix. Attitude towards learning biology and metacognitive awareness of control group, IBLMG and CLMG are correlated significantly.

x. Home environment and gain score of control group, IBLMG and CLMG are not correlated significantly.

xi. Metacognitive awareness and gain score of control group are not correlated significantly.
Metacognitive awareness and gain score of IBLMG and CLMG are correlated significantly.

xii. Attitude towards learning biology and gain score of control group, IBLMG and CLMG are not correlated significantly.

xiii. Metacognitive awareness, attitude towards learning biology and the dimensions of home environment are significantly influenced the gain score of IBLMG students.

xiv. Metacognitive awareness, attitude towards learning biology and the dimensions of home environment are significantly influenced the gain score of CLMG students.

xv. Metacognitive awareness, attitude towards learning biology and the dimensions of home environment are not significantly influenced the gain score of control group students.

5.3 DISCUSSION

A number of researchers like Brown(1987), Hartman(2001), Coutinbo(2007) and Magno(2010) have recommended for the rational reform of science teaching and learning in the classrooms to improve the performance in teaching and learning. The present study has taken cognizance of it and attempted to develop an metacognitive model in biology for higher secondary students for improving the teaching and learning in biology. Schraw(2004), Kramarski.et.al(2004), Coutinbo(2007), Ozsoy et.al.(2008), Pulmones (2009) and Ibe(2009) asserted the importance of metacognition as one of the instructional tools. Indeed the present study has integrated metacognition into an instructional design. The findings of the longitudinal case study done by Lin (2008) revealed that teaching strategies using metacognition improved the critical thinking skills
of science students. Saravanakumar and Mohan (2007) revealed that metacognition could improve the science achievement of students. Lin(2008) found that metacognitive awareness could improve the teaching competence. Ozsoy(2009) in his experimental study asserted that metacognitive activities were effective on mathematical problem solving. The findings of Ibe (2009) explored the influence of metacognition on the classroom participation of science students and found that the metacognitive strategies were most effective in enhancing academic achievement of learners. Hamdam et.al(2010) found that cognition was a significant predictor of performance of students. Chun et.al (2011) showed that metacognitive strategies into online instructions can effectively increase the effectiveness of the instructions.

In that way, the investigator developed metacognitive strategy model for improving the achievement in biology of the higher secondary students. The investigator aims to measure the achievement of higher secondary students in biology, using metacognitive strategy model in biology with home environment as sociological factor, attitude towards learning biology as psychological factor and metacognitive awareness as cognitive factor. Hence, the study not only concentrates on developing the metacognitive strategies in Biology and its effectives, but also aims to study the other intervening factors of learning biology among higher secondary students.

**Effectiveness of Metacognitive Strategy in IBLMG**

The results of the present study revealed that metacognitive strategies significantly improved the achievement in biology of standard XI students of IBLMG. The results are in agreement with the study result of

i. Ponnusamy (2006) who found that experimental group, who received metacognitive strategies received higher metacognitive awareness and could answer more high level cognitive questions.
ii. *Pulmones (2009)* who found that asking students to answer questions afforded them the opportunity to reflect on their thinking, thus fostering their metacognition.

iii. *Leutwyler (2009)* who found that experiment group received metacognition through inquiry perform better in achievement than control group.

iv. *Kanesa(2012)* who found that metacognitive reflection coupled with disciplinary inquiry has the potential to effect change in the teaching of scientific process and scientific thought, with the result that students become better critical thinkers and more scientifically literate.

Result of the study indicated that metacognitive awareness has significant correlation with gain score of IBLMG students. Therefore for every unit change in metacognitive awareness, there is corresponding increase or decrease in gain score. The results of the study are in agreement with the following researchers.

i. *Zakaria et.al(2007)* who found that, there was a significant relationship between metacognitive awareness and students’ achievement in mathematical problem solving.

ii. *Countinbo(2007)* who found that metacognitive awareness significantly correlated with reading comprehension of text-book.

**Effectiveness of Metacognitive Strategy in CLMG**

The results revealed that, metacognitive strategies in CLMG are highly effective in enhancing achievement in biology. This result supports the following findings. *Jbeili(2003)* found that metacognitive strategies using cooperative learning was effective in enhancing mathematical performance and mathematical reasoning among fifth grade students in Jorden. *Ibe(2009)* implemented metacognitive instruction through think-pair-share strategy is effective on classroom participation and science achievement.
Santiago (2010) found that experimental group received metacognition through peer interaction perform better in achievement in chemistry than the control group.

One of the major findings of the present study is that students taught using the cooperative learning approach scored higher marks in achievement in biology than those taught using the inquiry approach. This may have been achieved by the high level of students' participation in learning activities. All the students in the cooperative group performed specific roles in learning which are presented in the classroom to the benefit of all members of the group.

In the present study, the superiority of metacognitive strategies are remarkable in the achievement of different objectives namely knowledge, understanding and application. In achievement objective-wise comparisons, CLMG students taught through cooperative learning based metacognitive strategies performed better than control group. In the control group students remained passive listeners in the class while teachers were explaining the concepts of science. Maximum of time was taken by the teacher to talk and no time was given to the students to interact among themselves. Students involvement was found when there were questions raised by the teacher otherwise the students were silently listening to the teacher. Control group students were never given opportunity to interact among themselves.

The results of the study proved that the metacognitive activities helped the students to score better in retention test. The reason is that when conducting the class in metacognitive environment, the concept will be understood better in the student's memory. So they would be able to retain the matter for a much longer period than other students who are taught in the chalk and talk method.

CLMG students learn to cooperative with others. CLMG classroom atmosphere tends to be relaxed, questions are freely asked and answered, even the shy student found
it easy to be involved. CLMG students tend to become friendly with their group members. In face to face group members teach and encourage each other. Low achievers observe the activities of high achievers. In the control group, no group work or group discussion was carried out in the classroom. The students were patiently listening to the teacher who was teaching. There was total silence expected in the classroom.

The student's academic achievement can be increased if teaching strategies are planned and carried out systematically. Since metacognition is an inherent component in classroom teaching and learning, students must be taught how to develop and be aware of the strategies. The present investigation conceptualized from the findings that metacognitive strategies influenced the achievement in biology among higher secondary students. Based on this study the investigator strongly recommends that when metacognitive activities are given to higher secondary students, there should be some degree of individualization. Such activities will definitely enhance achievement.

Lin(2002) stated that peer interaction is central to the success of cooperative learning as it relates to cognitive understanding. Jbeili(2003) again emphasized that as learners, some of who might normally "turn out" or refuse to speak out in a traditional setting, become actively involved in the learning process through group interaction. Mcdonald(2005) noted that every cooperative-learning strategy, when used appropriately, can enable students to move beyond the text, memorization of basic facts, and learning lower level skills. This method which results in cognitive restructuring leads to an increase in understanding of all students in a cooperative group. This approach, according to Santiago(2010), is intended to heighten student's interest and to encourage positive attitude and feeling towards the subject. Adyin(2011) in their research “learning together and alone” found that cooperative learning enhanced more positive attitude towards subject members and the teacher.
Since the subject of the investigator is biology, it can be said beyond doubt that metacognitive activities will produce similar results with other biology topics also.

**Relationship between Home Environment and Metacognitive Awareness**

The coefficient of correlation between home environment dimensions and metacognitive awareness was not significant for control group, IBLMG and CLMG. Thus, it can be interpreted that metacognitive awareness had no dependence on home environment. The result of the present study is in agreement with Gulsum.et.al.(2010), who found that the parent’s educational level, number of reading materials at home, frequency of buying newspapers, presence of a separate study room, and presence of a computer with internet connection at home were not significantly associated with metacognitive strategy use and science achievement. Laut(2008) pointed out there is no significant difference in metacognitive abilities between students living in their home environment and also those who have moved away from their home environment and those who have away from their family to persure undergraduate education. Kanmani and Annaraja(2010) pointed out there is no significant association of educational qualification and occupation of parents with metacognition of computer science degree students. The result is contradiction with Rahman.et.al (2011) indicated that mothers’ education and parents’ guidance might play an important role in metacognition of students.

**Relationship between Attitude towards Learning Biology and Metacognitive awareness**

The coefficient of correlation between attitude towards learning biology and metacognitive awareness was significant for control group, IBLMG and CLMG. This finding agreed with the finding of Ponnuamy (2006) found that there was relationship between attitude towards learning history and metacognitive awareness. Koballa (1988)
noticed that metacognitive strategies and scientific attitude were positively connected. Metacognitive strategies in problem solving were having profound influence on enhancing attitude towards learning mathematics (Osborne.etal,2003). Ozsoy.etal(2008) showed that there is significant relationship between metacognitive awareness and study habits and attitudes in fifth grade students. This study substantiates the above research finding. Santiago.etal(2010) revealed that metacognitive environment in cooperative learning can improve science attitude and achievement. The present study supplements this result.

**Relationship between Home Environment and Attitude towards Learning Biology**

The coefficient of correlation between nurturance dimension of home environment and attitude towards learning biology was significant for control group, IBLMG and CLMG. Nurturance implies excessive, unconditional, physical and emotional attachment with child which had positive effect on attitude towards learning biology.

The coefficient of correlation between Conformity dimension of home environment and attitude towards learning biology was significant for control group, IBLMG and CLMG. Thus, it can be interpreted that conformity of home environment implies to work according to parent’s desires and expectations which had positive effect on attitude towards learning biology.

The coefficient of correlation between permissiveness dimension of home environment and attitude towards learning biology was significant for control group, IBLMG and CLMG. In permissiveness dimension of home environment, the parents given opportunities to express his views freely to their child and act without any interference from parents which had positive effect on attitude towards learning biology. This result agreed with the findings of
i. *Dayal and Indira* (2013) who found that protective, reward, conformity and nurturance home environment help in the development of scientific attitude of higher secondary students.

*ii. Kogce.et.al* (2009) showed that educational background of parents, occupation of parents play a crucial role in influencing students’ attitude towards mathematics.

### 5.4 EDUCATIONAL IMPLICATIONS OF THE STUDY

The findings and discussion of the present study have wide implications for the improvement of present system of school education on both theoretical and practical context. It provides guidelines to curriculum development, examination system and teacher education for the possible ways of minimizing the non-utilization of metacognitive strategies.

**Curriculum Development**

In the light of the present findings, following recommendations are made.

i. The cognitive assumptions of the science curriculum materials, particularly at the higher secondary level be re-examined according to students’ metacognitive ability.

ii. Model metacognitive strategy packages may be designed and developed by expert teams and made available to the teachers for their classroom.

iii. Textbooks are dominated by declarative knowledge (facts, definitions and descriptions) whereas procedural (knowing how, knowing why) and situational knowledge should be provided for deep study processes. Text book should be designed by raising meaningful and interesting questions and emphasizing applications. Space may be provided adopting metacognitive strategies in having atleast for a few topics.
iv. The existing curricula will not be able to cope with the proposed metacognitive strategies. So the curricula must be modified accordingly. To attain achievement objectives more number of research on metacognitive strategies should be conducted and the strategies should be incorporated in the curriculum.

**Examination system**

The examination or assessment systems and the way these are conducted have a great impact on implementation and the success of a curriculum. Today, the purpose of science education is not give information to students; instead, it is concerned with the development of a wide range of knowledge and understanding, skills and attitudes, process and procedure in science. But, the examination system is so structured that it only judges knowledge of students and their ability to recall memorized facts. No effect is made to assess the metacognitive ability of the students to apply their acquired knowledge in a different situation. In the light of the above proposition it is recommended that

- In order to help students develop metacognitive skills, the examination system should be restructured and the method of assessing students’ achievement be reexamined. Questions set in the exam papers should not aim at assessing students’ knowledge by recall of facts. Provision must be made to assess higher order thinking skills and intellectual abilities.

**Teacher Education**

The study has important implications for teacher education. Teacher trainees understand how to structure and monitor meaningful learning experiences for students. The classroom teacher has a critical role in the turning of actual classroom situations into a metacognitive way. Teacher trainees should have an awareness of know-how of metacognitive skills, how it can be instilled and developed among pupils and how the
stage can be prepared for teaching-learning process. Therefore practice should be given to develop metacognitive skills for teacher trainees during inter-teaching practice.

5.5 RECOMMENDATIONS

Based on the findings of the present study, the following suggestions are made for implementation of the metacognitive strategies.

**Teachers**

i. Teachers need to bring in paradigm shift from teacher centered methods of teaching to student centered methods, making the students move away from rote memorization to metacognitive way of learning.

ii. Teachers should make effort to reduce teacher dependent learning situations allowing more space to the students to learn by self-planning, self-monitoring, self-evaluation and self-regulation.

iii. Teachers need to create metacognitive environment to the students in the regular class, wherein there is scope of interaction among the students. More emphasis should be laid for processes of science rather than product of science.

iv. While adopting metacognitive strategies in the classrooms, the teachers should give feedback about the practice of metacognitive activities, which will help them to use it appropriately.

v. Teachers should give more opportunities to students practice metacognitive activities. As students practice the activities, provide guidance and support to the students. Give them feedback until they can use the activities independently. As part of your feedback, inform them about where and when the metacognitive activities are most useful.
vi. Group activities proved to be effective and must be encouraged to develop metacognitive skills for all science subjects.

vii. It is found in the study that a positive relationship exists between home environment and attitude towards learning biology. Hence parents must provide special attention to the educational needs of children. The teachers are needed to identify the nature of home environment of each student in their class. The teachers may interact with parents to provide feasible atmosphere for learning at home.

**Policy makers**

i. From the findings of the study, the higher secondary students learn better by the use of metacognitive strategies. Hence there is a need to change the teaching methods and strategies adopted in higher secondary level.

ii. Special attention is required when a student has significantly greater difficulty in learning than most students of their age. They were not given special care in their studies nor do teachers identify them as low achievers. From the findings of the study, the low achievers would also show considerable improvement if teachers select the metacognitive strategies that would remove their mental deficit.

iii. Chalk and talk method of teaching biology are not compatible with attaining conceptual learning and higher-order cognitive skills. A major purpose of science education should be to develop instructional practices for developing scientific reasoning skills, critical thinking and decision-making capacity. Since metacognition is an inherent component in developing cognitive skills, students and teachers must be taught how to develop metacognition among students. State level academic bodies should develop metacognitive skill enrichment activities.
iv. Appropriate incentives needs to be provided to the creative teachers to motivate them by making their work known to the rest of the teachers to implement it in their schools also.

5.7 SUGGESTIONS FOR FURTHER RESEARCH

Based on the findings of the present study, the following suggestions are made for further research in order to improve the implementation of the metacognitive strategies.

i. The present study was carried out to find the effectiveness of metacognitive strategies on achievement in biology among higher secondary students who opted biology as one of the subjects. It is suggested to carry out the study in other subjects like Bio-technology, Microbiology, Bio-chemistry and Paramedical Chemistry.

ii. It is suggested that further study may be conducted by including vocational higher secondary students.

iii. This study can be extended by investigating multimedia with metacognitive strategies, to know the effectiveness of ICT on developing metacognitive skills of the students.

iv. A longitudinal study can be taken up for effectiveness of metacognitive strategies for the group of students for a period covering primary, upper primary, high and higher secondary classes.

v. A study can be taken up to compare the effectiveness of metacognitive strategy with other strategies by taking more number of control groups.

vi. The present study was delimited to only six topics rather a study can be taken up covering entire content area.
vii. A study can be taken up to compare the metacognition of the students studying under Tamilnadu state board and the students studying the syllabus of various boards.

viii. Since there are many methods present in cooperative learning, other methods like Student Teams Achievement Division (STAD), Learning together and Group investigation can be adopted to find its effectiveness.

ix. There are so many psychological factors influence the metacognition of the individual. In this study, the investigator taken an effort to consider the psychological factor which are related to the metacognition are metacognitive awareness, attitude towards learning biology. But further studies can be done by considering the psychological factor like brain dominance, components in multiple intelligence, learning style adopted by the students which influence the metacognition of the individuals.

5.8 CONCLUSION

Any one can claim that they are teaching, but not every teacher can assertively claim that students are learning. Teachers can assist their students to become successful learners provided if they are teaching specific subject matter; they also can show their students how to study the subject. In other words teachers must improve their learning abilities. It is believed that creating a metacognitive learning environment in a classroom is the responsibility of the teacher. The teacher can manipulate the strategies and techniques in the classroom in a way that suits the students. This study has shown that achievement of students is related to the metacognitive strategies used by the teacher in the classroom.
Knowledge can be efficiently gained by self directed learning. It is basically a shift from known to unknown. The present study is undertaken to develop metacognitive strategies in biology among higher secondary students. Instead of focusing on the content of the subjects, suggesting the means and ways of learning will be more helpful to the learners. Students come to learning situation with varying of cognitive awareness about that learning. The level can range from no cognitive awareness to high level of cognitive functioning. The teacher's task is to determine the student's level of cognitive awareness and metacognitive strategies that help to achieve goals. This will make the learners to become self dependent and goal directed achievers. Metacognitive strategies are sequential process that is used to control cognitive activities and to ensure that a goal has been met. The present study was undertaken to analyse the metacognitive strategies and how one can overcome the shortcoming seen in the field of biology.