CHAPTER 6

SUMMARY OF THE MAJOR FINDINGS, DISCUSSION, IMPLICATIONS, RECOMMENDATIONS AND CONCLUSION

The aim (of education) must be the training of independently acting and thinking individuals who, however, can see in the service to the community their highest life achievement.

Albert Einstein

6.1 Introduction
This chapter deals with summary of the major findings, Discussion, Recommendations and Educational implications and Conclusions.

6.2 Major Findings of the study
The following are the major findings that are obtained by testing the hypotheses quantitatively and by answering the research question qualitatively:

1. Post-test score of B.Ed trainees in Control group in Science Teaching Competence, Metacognitive awareness, Use of Metacognitive Instructional design and Knowledge of ICT and multimedia components is significantly greater than that of pre-test.
2. e-Content in Science is effective on enhancing Science Teaching Competence, Metacognitive awareness, Use of Metacognitive Instructional design and Knowledge of ICT and multimedia components.
3. Orientation on Science Teaching Competence model of the e-content is effective on enhancing Science Teaching Competence, Metacognitive awareness, Use of Metacognitive Instructional design and knowledge of ICT and multimedia components.
4. Control group, Experimental group I and Experimental group II do not differ significantly in their Science Teaching Competence and Knowledge of ICT and multimedia components in the pre-test and they differ significantly in Metacognitive awareness and Use of Metacognitive Instructional design.

5. Control group, Experimental group I and Experimental group II differ significantly in their Science Teaching Competence, Metacognitive awareness and Use of Metacognitive Instructional design in the post-test and they do not differ significantly in their Knowledge of ICT and multimedia components in the post-test.

6. The variables Metacognitive awareness, Use of Metacognitive Instructional design and Knowledge of ICT and multimedia components do not contribute significantly to Science Teaching Competence of Control group in the pre-test.

7. The variables Knowledge of ICT and multimedia components is significantly contributing to Science Teaching Competence of Control group in the post-test rather than Metacognitive awareness and Use of Metacognitive Instructional design.

8. The variables Metacognitive awareness, Use of Metacognitive Instructional design and Knowledge of ICT and multimedia components do not contribute significantly to Science Teaching Competence of Experimental group I in the pre-test.

9. The variables Metacognitive awareness and Use of Metacognitive Instructional design do significantly contribute to Science Teaching Competence of Experimental group I in the post-test rather than Knowledge of ICT and multimedia components.

10. The variables Metacognitive awareness, Use of Metacognitive Instructional design does not contribute significantly to Science Teaching Competence of Experimental group II in the pre-test.

11. The variables Metacognitive awareness, Use of Metacognitive Instructional design and Knowledge of ICT and multimedia components do significantly
contribute to Science Teaching Competence of Experimental group II in the post-test.

12. No dimensions of Metacognitive awareness and Metacognitive Instructional design contribute to Science Teaching Competence of Control group in the pre-test.

13. No dimensions of Metacognitive awareness and Metacognitive Instructional design contribute to Science Teaching Competence of Control group in the post-test.

14. No dimensions of Metacognitive awareness and Metacognitive Instructional design was found to be a predictor for Science Teaching Competence of Experimental group I in the pre-test.

15. In the post-test the dimensions of Metacognitive awareness such as Planning, Comprehension monitoring, Declarative knowledge, Conditional knowledge and Procedural knowledge were found to be contributing to Science Teaching Competence of Experimental group I while the dimensions of Metacognitive Instructional design such as Task analysis, preparation of Instructional material and Metacognitive reflection contribute to Science Teaching Competence.

16. As far as Experimental group II is concerned no dimension of Metacognitive awareness was found to be predictor for Science Teaching Competence in the pre-test and no dimension of Metacognitive Instructional design contribute to Science Teaching Competence in the pre-test.

17. In the post-test the dimensions of Metacognitive awareness such as Planning, Information management strategy, Comprehension monitoring, Declarative knowledge and Procedural knowledge contribute significantly to Science Teaching Competence and all the dimensions of Metacognitive Instructional design such as Task analysis, Instructional objective, Preparation of instructional material, Evaluation and Metacognitive reflection contribute significantly to Science Teaching Competence in Experimental group II.
18. There is significant correlation between the following variables of the Control group in the post-test.
   i) Science Teaching Competence and Knowledge of ICT & multimedia components.
   ii) Metacognitive awareness and Use of Metacognitive Instructional design.

19. There is significant correlation between the following variables of the Experimental group I in the post-test.
   i) Science Teaching Competence and Metacognitive awareness
   ii) Science Teaching Competence and Knowledge of ICT and multimedia components
   iii) Metacognitive awareness and Use of Metacognitive Instructional design

20. There is significant correlation between the following variables of the Experimental group II in the post-test.
   i) Science Teaching Competence and Metacognitive awareness
   ii) Science Teaching Competence and Use of Metacognitive Instructional design
   iii) Science Teaching Competence and Knowledge of ICT and multimedia components
   iv) Metacognitive awareness and Use of Metacognitive Instructional design

21. The direct influence of Metacognitive awareness Inventory on Science Teaching Competence among the student-teachers of Control group in the post-test is 0.55 and that of the indirect influence through Metacognitive Instructional design and ICT & Multimedia components are respectively 0.85 and 0.17.

22. The direct influence of Metacognitive Instructional design on Science Teaching Competence among the student-teachers of Control group in the post-test is 0.36 and that of the indirect influence through Metacognitive awareness Inventory and ICT and Multimedia components are respectively 0.85 and 0.35.

23. The direct influence of ICT and Multimedia components on Science Teaching Competence among the student-teachers of Control group in the post-test is 0.56
and that of the indirect influence through Metacognitive awareness Inventory and Metacognitive Instructional design are respectively 0.17 and 0.35.

24. The direct influence of Metacognitive awareness Inventory on Science Teaching Competence among the student-teachers of Experimental group I in the post-test is 0.61 and that of the indirect influence through Metacognitive Instructional design and ICT and Multimedia components are respectively 0.56 and -0.14.

25. The direct influence of Metacognitive Instructional design on Science Teaching Competence among the student-teachers of Experimental group I in the post-test is -0.28 and that of the indirect influence through Metacognitive awareness Inventory and ICT and Multimedia components are respectively 0.56 and -0.05.

26. The direct influence of ICT and Multimedia components on Science Teaching Competence among the student-teachers of Experimental group I in the post-test is 0.22 and that of the indirect influence through Metacognitive awareness Inventory and Metacognitive Instructional design are respectively -0.14 and -0.05.

27. The direct influence of Metacognitive awareness Inventory on Science Teaching Competence among the student-teachers of Experimental group II in the post-test is 0.24 and that of the indirect influence through Metacognitive Instructional design and ICT and Multimedia components are respectively 0.66 and 0.66.

28. The direct influence of Metacognitive Instructional design on Science Teaching Competence among the student-teachers of Experimental group II in the post-test is -0.15 and that of the indirect influence through Metacognitive awareness Inventory and ICT and Multimedia components are respectively 0.66 and 0.53.

29. The direct influence of ICT and Multimedia components on Science Teaching Competence among the student-teachers of Experimental group II in the post-test
is 0.33 and that of the indirect influence through Metacognitive awareness Inventory and Metacognitive Instructional design are respectively 0.66 and 0.53.

30. The design of the template could draw attention of the target group.
31. The multimedia components are effectively integrated into the module.
32. Objectives are defined well and they are achievable.
33. Pros and cons of each module are effectively presented and they will be informative to the student-teachers of science.
34. Metacognitive assessment for the student-teachers will help them improve their professional preparation.
35. Competence educates the skills to be developed by the student-teachers.
36. A student-teacher can easily to develop an e-content of their own by means of steps to be adopted for the development of e-content.
37. Story board is well written. Language is very simple and precise.
38. A student-teacher could be educated on how to evaluate their students for a topic in science.
39. Metacognitive Instructional design is an innovative design and it is original and unique.
40. Script for student-teachers of science for all the three topics is well planned.
41. Glossary serves its purpose.

6.3 Discussion
Graham and Renata Phelps (2003, 2008), Gertrude Hennesssey (2003), and Gregory Schraw (2005) 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 experimental study made by Anne Morris (2006) reveal that videotaped mathematics lesson could improve the instructional skills of pre-service teachers. David Devaraj Kumar and Robert Sherwood (2007) studied the effectiveness of multimedia in science teaching with K-9 students. Their findings revealed that multimedia could improve the performance of the students in science. Balakrishna Muniandy and Fong Soon Fook (2007) in their study proved that multimedia authoring is effective among the pre-service teachers. Savittree Rochanasamita et.al (2008) found multimedia tools could put pre-service teachers into a comfortable zone in teaching science. It is noted from the study done by Omwenga et.al (2005) that e-content was effective with the university lecturers. The present study is in agreement with the above mentioned studies. e-Content was effective in improving the science teaching competence of student-teachers at Secondary level. The findings of the longitudinal case study done by Barak Miri et.al (2007) revealed that teaching strategies using metacognition improved the critical thinking skills of science students. Georgeniades (2004) in his experimental study asserted that metacognitive activities were effective on students’ learning. Savia Coutino (2006) found that cognition was a significant predictor of performance of students. Susan Sunny Cooper and Penee Steward (2006) found that metacognitive awareness could improve the teaching competence. The findings of Saravanakumar and Mohan (2007) revealed that metacognition could improve the science achievement of students. Ramganesh (2008) found that metacognition could improve the problem solving action of student-teachers at B.Ed.level. Helan Ngozibe (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. Sevgi Turani et.al (2009) found that problem
based learning improved metacognitive awareness and self regulated learning skills among medical students. Amutha and Ramganesh found that metacognition is related to instructional design and e-content development. Kramarshi and Gutman (2006) found that influence of metacognitive questioning in e-learning environments significantly outperformed in achievement and in using self-monitoring strategies. In that way, the present study used metacognition integrated instructional design for improving the competence in science teaching of the student-teachers. It ensured that metacognitive awareness and metacognitive instructional design were determining variables related to science teaching competence. The present study found that e-content with a Metacognitive Instructional design was effective in enhancing the Science Teaching Competence of B.Ed trainees of science in the rural areas.

6.4 Recommendations and Educational Implications of the present study

There was significant difference between pre-test and post-test scores in all the variables undertaken in this study including the Control group but the mean scores differed between control and the experimental group. The difference between the mean score of Science Teaching Competence of Control group was 3.63 and while it was 7.33 in Experimental group I and 9.61 for Experimental group II. The difference of Experimental group II was higher than that of Control group and Experimental group I, which indicates the influence of orientation on Science Teaching Competence model.

The mean difference between the scores of Metacognitive Awareness of Control was 3.78, Experimental group I was 2.66 and Experimental group II was 3.83. The gain score of Experimental group II which was e-content with orientation was higher than Control and Experimental group I. It shows the Experimental group II has more Metacognitive Awareness than the other two groups.
As far as the use of Metacognitive Instructional design is concerned, the Control group outperformed the Experimental group I and Experimental group II. The sample group being the student-teachers, though they have previous knowledge about Instructional design, their Science Teaching Competence is lower when compared with Experimental group I and II. Hence it is suggested that the e-content treatment should be given to Control group for the better performance.

Regarding the knowledge of ICT and multimedia is concerned, Experimental group I is better than Control group. The Experimental group II score shows better results than the other two groups. This trend of improvement in all the variables studied due to inclusion of e-content and Metacognition was confirmed by the analysis of variance. The correlation studies also corroborated the results of the ‘t’ test and ANOVA indicated that there is a strong correlation between the variables and the improvement expressed in the post-test. The regression analysis reveals the influence of these intervening variables on Science Teaching Competence. Also the path analysis reveals the direct and indirect influence of these variables on the enhancement of Science Teaching Competence among the student-teachers of science in the rural areas around Tiruchirappalli.

On the basis of the statistical treatment and qualitative analysis of the data, the recommendation and educational implications have been evolved and discussed.

1. New and novel techniques pertinent to metacognition may be evolved to help the trainees to conceptualize the concept of teaching of science. As e-content in the select topics of science is found to be effective in enhancing Science Teaching Competence of student-teachers, they may be oriented to identify the content in science for which e-content could be developed and trained to develop e-learning modules of their own.

2. Positive moderate correlation between Science Teaching Competence and the intervening variables such as Metacognitive awareness, use of Metacognitive Instructional design and knowledge of ICT and multimedia components reveal that Science Teaching Competence is positively affected by these intervening
variables. Hence initiatives may be taken to orient the student-teachers or teachers on metacognition. They may be guided through proper means to integrate metacognition into the instructional design. The teachers also are to be trained to posses the knowledge of ICT skills and multimedia components.

3. It is observed from the findings of the present study that the investigator’s orientation on Science Teaching Competence model of the e-content played a significant role in enhancing the Science Teaching Competence of student-teachers. Hence teachers’ orientation on instructional design of his/her e-content is essential rather than keeping the e-content as self-instructional.

4. Certain dimensions of Metacognitive Awareness such as Planning, Comprehension and monitoring, Declarative Knowledge and Information Management strategy were found to have contributed to Science Teaching Competence only after the treatment (e-learning modules) was given. Hence the positive association of the above mentioned components with the e-content may be taken cognizance for the enhancement of Science Teaching Competence. It is recommended to orient these components by the efficient means to the student teachers.

5. Certain components of Metacognitive Instructional design such as task analysis, instructional objectives, and preparation of instructional material, evaluation and metacognition reflection were found to have contributed to Science Teaching Competence only after the treatment was given. This clearly proves the worthiness of integrating metacognition into the instructional design of the e-learning modules. Hence integrating metacognition into the instructional design will be of cardinal help to the student-teachers of science.

6. Though teaching strategies are familiar to the science teachers, they must know the specific strategies for the given task to make the teaching more effective and also they must be well acquainted with the use of latest innovative teaching strategies.
6.5 Recommendations for future policy decisions

Research in general and educational research in particular must be committed to contribute to recommendations for future policy decisions on the basis of the findings of the research. In that way, the present study is committed for the following recommendations for policy decisions in empowering science education:

1. The orientation on the development of e-content may invariably be given to the teachers at all levels as the e-content was proved to be effective in the present study.

2. Adequate infrastructure may be established in the educational institutions at all levels for the development of e-learning modules by the teachers for the students.

3. As teachers’ ICT skills and awareness of multimedia components are positively impacted on the development of e-content, the concerned departments should organize appropriate training programmes for the teachers at all levels to get mastery over the ICT skills and multimedia components.

4. The strategic perspectives of metacognition may be incorporated in teacher education curriculum at all levels as an instructional strategy. In the present study Metacognitive awareness was positively associated with teaching competence.

5. The idea of integrating the components of metacognition into instructional design, the so called Metacognitive Instructional design was endorsed to be a unique design of its kind for the development of the e-content in this design. Competences such as Declarative Knowledge, Conditional Knowledge, Identification of tasks complexity, Adjusting pace, Access to content and tools, Planning of instruction, Self-monitoring the task performance, Organizing the content, Strategy planning, Demonstration, Graphics Organiser, Concept Mapping, Gap analysis, Performance gap are to be recognized as Science
Teaching Competence and they are incorporated in the curriculum of science teaching.

6. Student-teachers of science at secondary level may be oriented on the search of e-resources in the internet pertinent to the topics identified for the development of e-content.

7. Appropriate software such as Adobe premiere editing and Flash and Dream viewer for the development of animation may be incorporated in the teacher education curriculum at secondary level. It is imperative right now as the teacher in the present scenario is to win the confidence of the students using modern technology. Moreover making students to be independent in their learning is one of the predominant responsibilities of the teacher.

8. Experts may be identified in science teaching to guide the student-teachers to draft the pros and cons of the topics in science that are identified for the development of e-content with a Metacognitive Instructional design.

6.6 Recommendations for future e-content developers

On the basis of the findings of quantitative, qualitative and SWOT analyses the following recommendations are given for the future e-content developers:

1. As knowledge of ICT skills and multimedia components is directly impacted on e-content, they are essential for the e-content developers.

2. It is important for them to be aware of the e-resources were they can collect texts, images, animation and video pertinent to the topics selected for the development of e-content.

3. An e-content developer as student-teacher or teacher must be trained to prepare script and story writing using an instructional design.

4. It is recommended that the e-content developer is required to be aware of the initiatives of the e-resources including templates by University Grant Commission’s Consortium for Educational Communication.
5. As some of the experts suggest for the e-learning modules of the present investigation, “Sam Serif” font may be taken cognizance with the font size more than 12.

6. The hyperlink functionality may be well taken care of throughout the e-content in the present study. Some of the experts suggested the present study to improve the hyperlink functionality.

7. Delivery of the presenter is to be well rehearsed.

8. The presentation may be recorded in a quite environment equipped with adequate infrastructure.

9. For an e-content developer to prepare the modules independently he/she must have a mastery over Flash, Dream Viewer, Adobe premiere or You Lead software.

10. As some of the expert suggested to have video modules in the right side of the template, the same may be taken cognizance of for drawing attention of the users.

11. Some quiz questions pertaining to the content may be given in the modules for the better assessment of the users.

12. Content preparation may be entrusted to the expert teachers.

13. The copyright of the video clips downloaded from any site have to be obtained from the concerned wherever it is necessary.

6.7 Recommendations for Instructional Designers

The development of instructional design must be prepared by analyzing the actual and future design needs of science teachers. Moreover instructional design is the chief component of an e-content development. Hence instructional design must be taken cognizance of in the development of an e-content. As the present study developed a Metacognitive Instructional Design and integrated into e-content, the
following recommendations are given for the instructional designers on the basis of findings of the present study:

1. In the present study the Metacognitive Instructional design has greatly impacted on the e-content for the enhancement of Science Teaching Competence. Hence metacognitive elements such as developing, monitoring and evaluating the plan of action could be integrated effectively on the different dimensions of an instructional design identified by the present study such as Task analysis, Instructional objectives, Preparation of instructional materials, Evaluation and Reflection.

2. An orientation may be planned for the student-teachers of science for preparing script and story board using the Metacognitive Instructional design.

3. The suitability of the Instructional Design may be monitored for the development of e-content.

4. As task analysis has contributed to the enhancement of Science Teaching Competence of the sample of the present investigation, a workshop may be organised for the needy student-teachers of science at secondary level on the effective integration of metacognition into the task analysis.

5. The expertise of the concerned subject on the Educational Technology and Cognitive psychology may be obtained for the development of the Metacognitive Instructional design.

6. The Instructional design may be under the scrutiny of the developer and target group.

7. As the use of Metacognitive Instructional design has direct negative impact on Science Teaching Competence among the student-teachers of Control group, Experimental group I and Experimental group II, an effective orientation on Metacognitive Instructional design is to be given to the student-teachers of science. Instructional Design is a chief component for the development of e-content and it is an important entity for an effective teaching-learning process.
6.8 Suggestions for further research

Any good research even after answering its research questions must be inclined to update and innovate new ideas for further contributions to the needy people. In that way, the following suggestions for further investigations are made:

1. As the e-content of present investigation was not web-enabled, an e-content may be developed in science and web-enabled. A study may be attempted to find out the effectiveness of e-content in Science Teaching Competence of student-teachers at secondary level of different countries through internet inquiry.

2. As the Metacognitive Instructional design is a pioneering attempt in the present study an investigation may be attempted to compare the effectiveness of e-content with a Metacognitive Instructional design and any other instructional design such as ADDIE and Merrill on Science Teaching Competence of student-teachers.

3. The present study is attempted to find out the influence of select intervening variables such as Metacognitive awareness, Metacognitive Instructional design and ICT and Multimedia Components. Hence a study may be attempted to find out the influence of knowledge and skills of Flash, Dream Viewer and Adobe Premiere on the development of e-content.

4. The present study is attempted to empower the Science Teaching Competence of student teachers of science at the secondary level in the rural areas. Further study may probe the need analysis of student-teachers in rural areas; e-content may be developed on the basis of need analysis and effectiveness of e-content may be ascertained among the student teachers.

5. Science Teaching Competence scale was used in the present study to ascertain the competence of student teachers. It is suggested that Science Teaching Competence of them be ascertained by observing their classroom behaviour for a topic of science.

6. One of the findings of the present study reveals that Control group student-teachers could significantly improve their Science Teaching Competence,
Metacognitive awareness, use of Metacognitive Instructional design and knowledge of ICT and Multimedia components in the post-test compared to the pre-test without the treatment of e-content. Further study may explore the intervening variables responsible for the empowerment of these variables.

7. The present study has evolved a new model of Instructional design by integrating the components of Metacognition such as Metacognitive knowledge, Self-monitoring and Metacognitive evaluation. Further study may be attempted to evolve a unique design by integrating some other components of metacognition such as meta-memory, orchestration, meta-comprehension etc., and further e-learning modules may be prepared using that Instructional design for finding out its effectiveness.

8. As the present study has attempted to educate the prospective teachers of science on the development of e-learning modules, it would be meaningful to explore the effectiveness of e-learning modules to be developed by student teachers themselves in science. Further the study may address the difficulties of student-teachers in the development of e-learning modules.

9. A study may be initiated to develop one’s own animation, images and video clips relevant to the select content in teaching of science for the development of e-content. The e-content of the present study and the one to be developed may be compared.

10. As the pros and cons of each module are opined to be effective, pros and cons of all the learning concepts in a unit in science may be developed and investigation of the same may be mooted on how far these pros and cons are informative for the sample.

6.9 Conclusion

In the light of the research findings it is felt that the present piece of research may contribute on alleviation of difficulties of B.Ed. trainees in the rural areas in
teaching of science with modern technology. It is hoped that appropriate instructional design so called Metacognitive Instructional design may be given for the needy trainees and the findings of the study may be taken into consideration for a better framework in developing Science Teaching Competence among the B.Ed. trainees by implementation of this innovative strategy. The recommendations that have emerged from the findings of the present study will provide an opportunity to realize the dream of quality teaching of science envisaged in the National Educational Policy. The present investigation is a humble and modest endeavour towards this objective.