CHAPTER V
DISCUSSIONS ON RESULTS AND CONCLUSIONS

Summary of findings from the research questions posed in 1.17.1 through 1.17.6 along with other concluding remarks and recommended future research extensions based on this research work, have been presented in this chapter.

5.1 Findings on Research Questions

5.1.1 On the Overall Presence of ‘Creativity’

From the Table 4.41, it is found that the average percentage of creativity (both directly used action verbs and indirectly used verbs) is around 25 % in the University Question Papers, whereas from Table 4.43 it is found that the average presence of ‘Creativity’ is 34% in the allocation of marks for University questions. In other components of the curriculum, viz., the prescribed textbooks and the syllabus content (units), it is found from Table 4.74, that the average presence of ‘Creativity’ component is around 7%. From questionnaires and the feedback responses collected, it is found from Table 4.77, that the presence of ‘Creativity’ in other components of curriculum, viz., classroom teaching was found to be near 25%, whereas the presence is found to be 65% in Students’ project work and Laboratory classes.

The requirement of ‘Creativity’ competency is ‘High’ (ie., 75%) for B.E (CSE) as per the benchmark arrived at by experts. When compared with this requirement, it is observed that the overall presence of creativity that is actually found in various components of the curriculum is relatively poorer.

Thus it is found from this research work that the presence of ‘Creativity’ competency is meagerly found in all the components of the curriculum as seen from the results obtained. As stated in Research question 1.17.1, it is thus inferred that
there may not exist any policy in implementing ‘Creativity’ competency in the curriculum of B.E (CSE) of Anna University, through infusion.

5.1.2 On Uniform Presence of ‘Creativity verbs’ in all the Components

From the Table 4.41, it is found that the minimum percentage of creativity (both through directly used action verbs and indirectly used verbs) is only 6%. The maximum presence is 37%, whereas from Table 4.43, it is found that the minimum presence of creativity is 14% and the maximum presence is 68%. The above results shown in both the Tables referred are found from the University question papers, which include the percentage in the number of questions appeared and in the allocation of marks to the questions.

Analyses were done on other components of the curriculum, viz., in the prescribed textbooks and the syllabus content (units). From Table 4.74 it is found that the minimum presence is 0, i.e., nil and the maximum presence is 23%.

From Table 4.77, it is observed that the presence of ‘Creativity’ in other components of curriculum, viz., class room teaching was found to be 25%, whereas the presence is found to be 65% in Students’ project work and Laboratory classes.

It has already been discussed, that it would be easy to use ‘Creativity-oriented’ action verbs in University question papers, as questions always apply verbs. But the research findings actually show that the presence is found to be less than 50% in all the cases. In the cases of Laboratory practices and Students’ project works, the presence is found to be 65%.

Research question 1.17.2 poses on the uniform presence of ‘Creativity’ in all the components of the curriculum. This research work infers that the presence of creativity competency is not uniformly incorporated in all components of the curriculum of B.E (CSE).
5.1.3 On Uniform Presence of ‘Creativity verbs’ in University Question Papers

Among the twenty question papers analysed, none of the question papers has more than 50% representation of ‘Creativity’ competency, which includes both directly used ‘creativity’ based verbs and indirectly used verbs. It is found from this research work that question papers contain the maximum number of action verbs pertaining to ‘Creativity’ competency, when compared with any other component of the Computer Education curriculum. However, the question papers have less than 50% representation of creativity-oriented questions in all of the subjects. The subject ‘Linear Integrated circuits and applications’ has the maximum representation (44%) of ‘Creativity’ competency. It is observed that there is consistently a fairly good representation of ‘Creativity’ competency in indirectly used action verbs, compared to directly used action verbs in most of the subjects, as the coefficient of variation is comparatively less in the latter case.

Research question 1.17.3 poses whether the presence of creativity in all the University question papers is uniform.

Twenty question papers have been analysed with respect to the percentage of marks allotted to questions. The presence of ‘Creativity’ is found through both directly used action verbs and indirectly used action verbs. It is found that four subjects have fair representation of ‘creativity’. As reported earlier, the four subjects mentioned there, also have low representation of percentage of marks allotted to questions. It is found that directly used action verbs and indirectly used action verbs have very wide variations compared to that of no. of question papers as observed in 5.1.2.

A comparison on the co-efficient of variations of percentage of marks allotted to creativity with that of no. of questions is made. It is noticed that in majority of the question papers used, the percentage of directly used ‘Creativity’ verbs is higher than the percentage of indirectly used ‘creativity’ verbs. This shows that the directly used
action verbs are more than the indirectly used action verbs. But as the co-efficient of variation is more in direct usage compared to indirectly used verbs, the indirectly used verbs are more consistent in its usage. It is noticed that in the case of percentage of marks allocated, the representation of ‘creativity’ is fairly the same in both directly used as well as indirectly used action verbs. It is also found that the co-efficient of variation is fairly the same and the consistency is similar in both the cases.

It is inferred from the results, that the presence of ‘Creativity’ in the University question papers is not only less (less than 75% as prescribed by experts) but also not uniformly present as posed in the research question 1.17.3.

5.1.4 On the presence of ‘Creativity verbs’ in Individual subjects


5.1.4.1 On the overall presence of ‘Creativity verbs’ in Unit contents of subjects

It is observed that the overall presence of creativity competency among various units in several subjects, pertaining to the Computer Science & Engineering of Anna University is found to be less than 50% and also found that it is not uniform in all units of all the subjects.
Among the various subjects for which, direct and indirect usage of creativity verbs is analysed, the creativity may be less in initial portions such as unit I, but it is expected to increase gradually and to be high in the last unit viz., V unit. But it is found that the variation in the presence of ‘Creativity’ competency is casual and in a haphazard manner. It is also observed that presence of indirect usage of creativity verbs is less than that of the directly used creativity verbs for many subjects.

By comparing all the subjects for creativity, there is no increase in creativity except for four subjects. Some subjects have high creativity in the III and IV units and there is no (very little) creativity in the V unit. In ‘Analog, Digital and Data Communication’ subject, there is a high percentage of creativity in the third, fourth and fifth units, but they all do not have direct usage of creativity verbs.

Directly used verbs are more than the indirectly used verbs among various subjects. It may also be noted that the consistency levels of indirectly used creativity verbs are less than that of directly used creative verbs.

5.1.4.2 On the presence of ‘Creativity verbs’ in Units of individual subjects

1. In the subject ‘Interactive Computer Graphics’, it is found that among five units, the direct and indirect usage of creativity verbs is high in the fifth unit. It is also found to be fluctuating in other units viz., I to IV. Hence the presence of creativity is inconsistent.

2. In the subject ‘Object Oriented Programming’, the direct usage of creative verbs is very high in the I unit and there is no usage at all in the rest of units. The presence of indirectly used action verbs is also not so significant in all the units. Hence the presence of creativity is inconsistent.

3. In the subject ‘Electronic Circuits’ the direct usage of creativity verbs is very low and equally distributed in the I and II unit; there is a slight increase in the III unit, high in the IV unit and it is less in the V Unit. In the indirect usage of
creative verbs, fluctuations are seen in the presence; it is high in units I & III, but there is substantial decrease in the IV & V units. Hence the presence of creativity is inconsistent.

4. In the subject ‘Semiconductor Physics and Opto-Electronics’ the direct usage of the creativity verbs is slightly high in the I unit and decreases in the second unit and there is a very high increase in III unit and there is a slack in the IV and V units. In the indirect usage of creativity verbs, the presence is zero in first and last units and fluctuating in all other units. Hence the presence of creativity is not so consistent.

5. In the Subject ‘Discrete Mathematics’ the direct usage of creativity verbs is high in Unit I; there is no creativity found in the second and third units; there is a slight increase in the IV unit and again it is absent in the V unit. In the indirect usage of creativity verbs, it is found to be very high in the I unit and it slacks in the II & III units and there is a slight increase in the IV Unit and dips in V unit. Hence the presence of creativity is inconsistent.

6. In the subject ‘Programming & Data Structures’ the direct usage of creativity verbs is not found in the I and II units and the use of creativity verbs is very high in the III unit and it slightly slacks in the IV and V units. In the indirect usage of creativity verbs, it is not found in I unit & II and it is very low in the III,IV and V units. Hence the presence of creativity is again inconsistent.

7. In the subject ‘Computer Architecture’ the direct usage of creativity verbs in unit I is totally absent; it rises in II and III units, while it is not at all found in the IV and V units. In the indirect usage of creativity verbs, it is feeble in I unit, present in II unit and slacks in III Unit and not at all found in IV & V units. Hence the presence of creativity is totally inconsistent.

8. In the subject ‘Analog, Digital and Data Communication’ the direct usage of creativity is not at all found in this subject. In the indirect usage of creativity
verbs, it is not present in I & II units and slacks very much in III unit and again absent in IV Unit and again rises in V Unit. Hence the presence of creativity is totally inconsistent.

9. In the subject, ‘Microprocessors’ the direct usage of creativity verbs gradually increases from I unit to II unit and is reasonably high in III unit and there is a slight slack in IV unit and is totally absent in V unit. In the indirect usage of creativity verbs, it is high in units I and II and it is totally absent in III, IV & V Units. Hence the presence of creativity is again found to be inconsistent.

10. In the subject, ‘Probability and Queuing theory’ the direct usage of creativity verbs is felt in I unit and decreases in II unit and again it is high in III unit and slacks in IV unit and is totally absent in V unit. In the indirect usage of creativity, it rises from I to II unit, dips in III unit; it is high in IV unit and totally absent in V unit. Hence the presence of creativity is fairly inconsistent.

11. In the subject, ‘Principles of Environmental Science & Engineering’ the direct usage of creativity verbs is present in I, II, & III units and it is not at all found in IV and V units. In the indirect usage of creativity verbs, it is absent in I, IV units; it is feebly present in II & III units and it is totally absent in V unit. Hence the presence of creativity is quite inconsistent.

12. In the subject, ‘Professional Ethics’ the direct usage creativity verbs are at all found in any of the five units. In the indirect usage of creativity verbs, it is present in I unit, rises in II unit and again fluctuates in III, IV and V units. Hence the presence of creativity is totally inconsistent.

13. In the subject, ‘Principles of Management’, the direct usage of creativity verbs is absent in all the units except II unit. In the indirect usage of creativity verbs, it is very high in I, III & V Units, less in II & IV units. Hence the presence of creativity is found to be quite inconsistent.
14. In the subject, ‘Object Oriented System Analysis and Design’, the direct usage of creativity verbs is absent except I and III units. In the indirect usage of creativity verbs, it is very high in I & V Units, less in II & III and extremely low in V unit. Hence the presence of creativity is found to be inconsistent.

15. In the subject, ‘Network Protocols, Management and Security’, the direct usage of creativity verbs is relatively high in I unit, has a slack in II & III units; it rises in IV unit and again dips in V unit. In the indirect usage of creative verbs, it is very high in I unit and reasonably low in II & III units; it rises again in IV unit and is totally absent in V unit. Hence the presence of creativity, is once again inconsistent.

Research question 1.17.4 poses whether the presence of ‘Creativity’ competency is uniform in the syllabi of all the subjects (unit content) and in the prescribed text books of B.E (CSE) syllabus. The above analyses on the results obtained, show clearly that the presence is not uniform in all the subjects of the syllabi and also that it is not uniformly present in the unit contents of every subject taken in to account.

5.1.5 Comparison between University question papers and other components of Curriculum

Research question 1.17.5 poses whether there is any significant difference in ‘Creativity’ competency between the University questions and other components of the curriculum.

It was discussed in 5.1.2 that although it would be easy to use ‘Creativity’ oriented action verbs directly in University question papers, the presence was lower than 50% (reported as in 5.1.3). It was also reported in 5.1.4.1 that the overall presence is less than 50% in the case of text books and unit contents of the syllabus of B.E (CSE). It was also observed and reported in 5.1.2 that except in the case of
students' project work (wherein it was found to be 65%), all other components of the curriculum show a poor presence of 'Creativity' component. Hence the results show that there is no significant difference found between University questions and other components of the curriculum.

5.1.6 On the Presence of Creativity in Formal { M.Sc., (I.T) } & Non-formal Computer Education

The actual usage of creativity verbs in class room teaching, when compared with other methods such as Laboratory classes, Project works are found to be high, both in formal & non-formal computer education; this is in accordance with the feedback responses obtained from respondents. The usage of creativity verbs is less than 50% in both the cases.

The usage of creativity verbs in the reference materials of both the formal and non–formal computer courses are observed to be below 50%. However in comparison with the other components such as the Laboratory Classes, Question papers etc., the usage level of creativity verbs found in reference materials is relatively high.

5.1.6.1 On Laboratory Classes and Student Project Works

The usage of creativity verbs in laboratory classes and student project works is found to be less than 40% in formal computer education. In non-formal education, it is found to be less than 10% only.

5.1.6.2 On Question Papers

The usage of creativity verbs in question papers is 40% in the case of formal education and observed to be only 20% in the case of non-formal education. Although it is expected to be quite high in this component, as usage of action verbs is easy, it is observed to be only 20% in the non-formal education.
The actual usage of creativity verbs in the laboratory classes and student project works is found to be less in comparison with the other components such as class room teaching, reference materials and question papers etc.,

It is observed that the usage of creativity verbs in classroom teaching and in reference materials in the case of non–formal education, to be less compared to that of formal education; this may be due to the fact that the methods adopted in following the reference materials alone, while teaching in non–formal courses. While comparing the usage in Question papers, Laboratory classes and Project works, the percentage in non–formal education is much less than that of formal education. It shows that these components are taken enough care in the formal computer education.

### 5.1.6.3 Comparison of ‘Creativity verbs’ in Textbooks of Different Subjects

An analysis was carried out from the results obtained, in comparing the presence of creativity component in textbooks and reference materials pertaining to formal and non–formal computer programmes. Four subjects have been taken for the analysis viz., C++, Java, Web Technology and Visual Programming. It is found that in all these four subjects, the creativity component is less than 40% for both formal and non–formal computer education.

In the reference materials and textbooks pertaining to C++, it is found that the usage of creativity is less than 40% in formal computer education and in the case of the non–formal education the usage of creativity is only 20%.

Observing the usage of creativity in Java, it is only 35% in formal education and it is less than 15% in non–formal computer education.

The lowest percentage is found to be in the subject ‘Web Technology’. In both the cases, it is only 30% in formal and non–formal computer education; the usage of creativity is only 5% which is found to be the least among all the other subjects.
Observation is also found to be a method of enhancing creativity; in the subject ‘Visual Basic’, it is 35% in the formal education and only 10% in the case of non-formal education.

It may be stated that the subjects dealing with programming Viz., C++, Visual Programming and Java tend to have more creativity component, while the qualitative subject viz., Web Technology would have lower ‘Creativity’ component.

5.1.6.4 Presence of ‘Creativity verbs’ in the Textbooks of Formal Computer Education

A comparison is made between the textbooks as suggested in the curriculum for the selected four subjects Viz., C++, Java, Web Technology and Visual Programming. Among all the four subjects, the presence of creativity component is high in textbooks, in comparison with other components of the curriculum.

In the subject C++, the creativity component in the textbook is more than 35%.

In Java, the usage of creativity component used in textbooks is 30%. In Visual Programming, the usage of creativity is 35% in the case of textbooks.

It may be noted that the textbooks are written not exclusively for the course M.Sc., (IT) but also for so many other relevant courses..

5.1.6.5 Feedback responses of students on various components of Formal Computer Education

It has been observed from the feedback responses of the students of formal computer education, that all the facilities such as class room teaching, reference materials, Laboratory classes, Project Work and Question Papers pertaining to creativity component of M.Sc (IT) Course are less than 50%.
In comparison with the reference materials in classroom teaching and other components such as Laboratory classes, Project Works and Question Papers, the former components have creativity content of below 45% only.

As posed in research question 1.17.6, the presence of ‘Creativity’ competency is not found to be uniformly present in other Formal Computer Education { M.Sc., (IT) } and Non-formal Computer Education in the state of Tamil Nadu.

5.2 General Outcome

The study has established the need for the implementation of ‘Creativity’ competency as an important objective in the Computer Engineering curriculum. The study facilitated the identification of several components of Computer Engineering curriculum for implementation. The research enabled the identification of the differences in the objectives of Formal and Non-formal Computer Education with special reference to ‘Creativity’ competency.

5.3 Suggestive Future Extension of Research work

5.3.1 The state of Tamil Nadu has Diploma level streams in the areas of Computer Technology and IT. Similar course content analysis can be made between B.E (CSE) and Non-formal Computer Education and the Diploma streams. The present research work may be extended to the study on the curricula of Polytechnic colleges in the state of Tamil Nadu or in any other state of India.

5.3.2 A model curriculum based on the research findings from this research work may be designed for B.E (CSE) and validated through need analysis.

5.3.3 The research work may be extended for the study on other aspects of Bloom's taxonomy viz., ‘Knowledge’, ‘Comprehension’ etc., in the curricula of B.E (CSE) compared with other disciplines of B.E., Courses offered in Tamil Nadu or in any other state of India.