Chapter 5

Findings, conclusions and recommendations

5.1 General background

India has a vast education system that produces large number of S&T professionals in different areas. The quality of education imparted determines knowledge-based growth. It is a proven fact that world-over, the institutions which excel in teaching do well in research. It is high time that we lay emphasis on quality teaching to increase over all standards of teaching and research in the country, if India is to compete globally for knowledge based economy. The universities not only contribute to the development of intellectual capital, but also generation of new knowledge. The success of any university is determined on the basis of academic culture, infrastructure, faculty research output and quality of students produced.

In the present study, the performances of universities and demographic variations of basic science education in India have been judged in terms of enrolment and selection of candidates in National Eligibility Tests conducted by CSIR through which Junior Research Fellowships are awarded for pursuing research in basic sciences. The classification of universities in three categories (i.e. the most performing, the moderately performing and the least performing universities) with respect to cumulative number of students enrolled and qualified in NET and the reasons delineating their performance on the identified factors have been discussed. Since the enrolment and
selections of candidates in NET from a particular state largely depends upon the level of educational infrastructure available and also on the proportion of government spending/expenditure towards university education, the efficiency of different states in fulfilling S&T capacity building goals have been analysed and discussed.

5.2 Findings and conclusions of the study

5.2.1 Revisit of the research questions and objectives

To recapitulate, the key objectives of the study as discussed in section 1.3 of the Chapter 1 are as follows:

i) To assess the performance of universities on the basis of CSIR research fellowship scheme.

ii) To measure the identified factors affecting the performance of universities and compare different categories of universities on each factor.

iii) To compare and characterize demographic efficiency in fulfilling science and technology capacity building goals through CSIR research fellowship scheme.

5.2.2 Major research contributions

The performance of academic institutions in fulfilling S&T capacity building goals has been assessed by analysing data pertaining to ten National Eligibility Tests conducted by CSIR. The relative capacity building efforts of universities in five subject areas have also been compared using Activity
Index. The repeated presence with respect to cumulative number of student enrolment and selections in NET resulted into three categories of universities as “Most performing”, “Moderately performing” and “Least performing”. The reasons of difference in the performance of three categories of universities on the identified factors have been measured. The hypothesis based on the comparison of three categories of universities on each of the identified factors has been validated using ANOVA one way (using SPSS 16.0). The demographic efficiencies in fulfilling S&T capacity building goals through CSIR research fellowship scheme have been compared by plotting scatter diagram of selection versus enrolment of candidates in NET, indicating the performance of states above and below the norm. The relative efficiency has been measured across different states using Data Envelopment Analysis (DEA).

The major research contributions are:-

1) With respect to the enrolment of candidates from more than 500 universities across the nation in ten National Eligibility Tests, it has been observed that only 20 universities showed their presence seven times and their share to total number of students enrolled was 41%. Sixteen amongst them repeatedly reserved their place in all the ten examinations. Selection profile of NET qualified candidates in the ten exams indicates that 60% of the qualifying students are only from 32 universities, which include 6 central universities, 25 state universities and one institute of national importance. Out of 32 universities, 16 universities consistently appeared in each exam in terms of cumulative number of qualified candidates. The remaining universities appeared nine times (six universities), eight times (six universities) and seven times (four universities). University of Delhi, Delhi reserved first place
as the maximum numbers of candidate have qualified NET from this university followed by University of Calcutta, Kolkata and Banaras Hindu University, Varanasi. Table 4.1 and 4.2 of Chapter 4 enlists the universities, which showed their presence, minimum seven times in ten National Eligibility Tests in terms of enrolment and selection.

2) By plotting a Lorenz curve of percent total selection and percent total enrolment, it was observed that from a group of top 32 universities, which repeatedly showed their presence at least seven times in ten National Eligibility Tests, 10 universities contributed 50% of the selections (Figure 4.1). Further it has been observed that 15 universities out of the top-20 universities in terms of enrolment also showed their presence in the group of top 32 universities in terms of qualified candidates and these universities contributed 33% of the total candidates qualified in NET.

Thirty two (32) universities, which have shown their presence minimum seven times in the ten exams, were further ranked on the basis of percent selection. The percent selection ranged between 0.98% and 28.12% with 19 universities in 0.98 - 5.0% range, 9 universities in 5-10% range and 3 universities in 10-15%. The top three institutions in terms of percent selection are Jawaharlal Nehru University, New Delhi (28.12%), University of Hyderabad, Hyderabad (13.60%) and Indian Institute of Technology, Roorkee (11.92%) ranked at seventh, fifth and sixth positions, respectively, in terms of number of qualified candidates. The top three institutions in terms of number of qualified students viz. University of Delhi, University of Calcutta and Banaras Hindu University are ranked at fourth, seventh and sixth positions, respectively, in terms of percentage of selection.
3. Though the numbers of universities and colleges have increased tremendously over the years and massive investments are being made for the development of human resource in basic sciences, the selection data indicates that less than 10% of the universities performed fairly well over the years in terms of number of candidates qualifying NET. Enrolment profile of NET qualified candidates indicates that over 50% of the total students supported by CSIR are working in institutions, rated as top 35 in terms of publication output in Scopus International database, 1999-2006 (Inderpal et al).

4) It has been observed that the universities, which are in top twenty (20) in terms of enrolment performed poorly in terms of percentage of selection except i) University of Delhi (rank 4), ii) University of Calcutta (rank 7), iii) Punjab University (rank 14), iv) University of Rajasthan (rank 17) and v) University of Pune (rank 19). Five universities, in spite of being in the top twenty in terms of enrolment could not make it in top thirty two universities in terms of selections. The remaining ten (10) universities in terms of percentage of selection are ranked between 19 and 32.

5) The huge differences in percent selection of the candidates from different universities in CSIR NET and only thirty two universities securing 60% of the fellowships repeatedly year after year remind us that concerted efforts must be made to raise the standard of teaching.

6) Activity Index of the universities in different subject areas with respect to number of enrolled and qualified students was computed to decipher the performance of the university in a particular discipline. The values of Activity Index-Enrolment [AI(E)] and Activity Index-Selection [AI(S)]
in different disciplines of 32 universities in terms of total number of enrolled and qualified candidates in NET are given in Table 4.4 and 4.5.

Based on the values of Activity Index, universities have been classified into four categories.

<table>
<thead>
<tr>
<th>1</th>
<th>AI(E) &lt; 100 and AI(S) &lt; 100</th>
<th>Universities with less than the average enrolment &amp; selections of candidates.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>AI(E) &lt; 100 and AI(S) &gt; 100</td>
<td>Universities with less than the average enrolment but more than the average selections of candidates</td>
</tr>
<tr>
<td>3</td>
<td>AI(E) &gt; 100 and AI(S) &gt; 100</td>
<td>Universities with more than the average enrolment and selections of candidates</td>
</tr>
<tr>
<td>4</td>
<td>AI(E) &gt; 100 and AI(S) &lt; 100</td>
<td>Universities with more than the average enrolment but less than the average selections of candidates</td>
</tr>
</tbody>
</table>

The universities where the

\[
\text{AI(E)} < 100 \text{ and } \text{AI(S)} > 100
\]

and

\[
\text{AI(E)} > 100 \text{ and } \text{AI(S)} > 100
\]

indicate better performance in a particular discipline. The tabular form depicting discipline-wise enrolment and selections of candidates from 32 universities in CSIR NET and their Activity Index is presented in Table 4.6 of Chapter 4.

7) The reasons of difference in the performance of universities (grouped into three categories of universities as “Most performing”, “Moderately
performing” and “Least performing” based on their repeated presence with respect to cumulative number of student enrolment and selections in ten CSIR National Eligibility Tests) have been measured and compared (Table 4.9). The summary of support obtained for the hypothesis based on the comparison of three categories of universities on each of the identified factors has been validated using ANOVA one way and presented in Table 5.1.
### Table 5.1 Summary of the support obtained for the Hypothesis

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Results</th>
<th>Category A and Category B</th>
<th>Category A and Category C</th>
<th>Category B and Category C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hypothesis 1:</strong> The Curriculum design and development practices in tune with the emerging national and global trends significantly differ in “Most performing”, “Moderately performing” and “Least performing” universities.</td>
<td>Not Supported</td>
<td>Supported</td>
<td>Supported</td>
<td></td>
</tr>
<tr>
<td><strong>Hypothesis 2:</strong> Teaching – learning process significantly differs in all three categories of universities.</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
<td></td>
</tr>
<tr>
<td><strong>Hypothesis 3:</strong> Initiatives towards promotion of research significantly differs in all the three identified categories of the universities.</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
<td></td>
</tr>
<tr>
<td><strong>Hypothesis 4:</strong> Infrastructure and learning resources significantly differs in all three categories of universities.</td>
<td>Not Supported</td>
<td>Not Supported</td>
<td>Not Supported</td>
<td></td>
</tr>
<tr>
<td><strong>Hypothesis 5:</strong> Student performance and learning outcomes significantly differ in all the three identified categories of the universities.</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
<td></td>
</tr>
<tr>
<td><strong>Hypothesis 6:</strong> Governance and management policies and practices significantly differ in all the three categories of universities.</td>
<td>Not Supported</td>
<td>Supported</td>
<td>Supported</td>
<td></td>
</tr>
<tr>
<td><strong>Hypothesis 7:</strong> Creativity and innovative practices are adopted in all the three categories of the universities.</td>
<td>Not Supported</td>
<td>Supported</td>
<td>Supported</td>
<td></td>
</tr>
</tbody>
</table>
8) The results of multiple comparisons on the identified factors reveals that “Infrastructure and learning resources” are adequately available in all the three category of universities. There is no significant difference in the factors that affect the performance of academic institution except Teaching – learning process, Initiatives towards promotion of research and Student performance and learning as experienced between the most performing and the moderately performing universities. There is significant difference between the most and the least performing universities and also between the moderately and the least performing universities in all the determinants which affect the performance of any academic institution.

9) The states of India have been ranked according to the number of candidates qualified and the percentage of selection on the basis of ten CSIR National Eligibility Tests. A simple scatter plot of selection versus enrolment revealed that Delhi and West Bengal perform better than the norm while Kerala and Tamil Nadu relatively underperform. It may be seen from the results of Data Envelopment Analysis (DEA) that out of the 17 states showing promise in CSIR NET enrolment, Delhi is the only state that remains efficient with a perfect score of 100. It is widely acknowledged that India is among the few nations that have demographic advantage, with large number of young citizens. Thus it is vital that our youth are provided the necessary training to enable them to compete globally.

10) Data Envelopment Analysis technique has been employed to further examine the relative efficiency of basic science education, in terms of the number of students qualifying CSIR NET in five subjects, viz. Chemical sciences; Earth, atmospheric, ocean and planetary sciences; Life sciences; Mathematical sciences and Physical sciences, across different states of the
country. The position of a particular state on the efficiency frontier could serve as a measure of capacity building in these disciplines. The vast differences in efficiency score across different states and union territories indicate need for directed efforts to upgrade the overall standard of basic science education in the country. A transparent, accountable, discipline-specific quality assurance system would ensure the best educational outcome.

5.3 Recommendations of the study

Higher education in basic sciences is fundamental for generating intellectual prowess necessary to sustain and augment economic growth and prosperity. Comparative lessons drawn from the study are helpful to design policies for capacity development, strengthen higher education system and bring reforms.

The recommendations emanated based on our research are:

1. The world is moving rapidly towards knowledge-based economy, foreign institutions are striving hard for higher education market. Research in science requires ambience where academic pursuits are encouraged, scholarship is prized and mediocrity is not consciously elevated. Unfortunately, the vast network of state funded universities in India with few notable exceptions requires remedial measures otherwise we may loose our prized human resource to foreign institutions.

2. Realizing the need of revamping the higher education system, the problem can be addressed in two ways:
i. Focused academic curriculum and world class faculty and infrastructure by establishing new institutions

ii. Bringing qualitative improvement in the existing institutions by reforming curriculum, upgrading infrastructure and policies to attract high quality faculty and students.

3. A number of criteria and assessment indicators based on curriculum aspect, teacher learning evaluation, research consultancy and extension, infrastructure and learning resource, student support and progression, governance and leadership and innovative practices are being used as guidelines to measure the quality of an institution. The number of qualified candidates in national/state level tests and their ranking in the overall merit list of candidates seeking admission are some of the factors that reflect the institutional effectiveness. Since the number of students qualifying CSIR NET from a particular institution is a direct reflection of the quality of teaching, it may also be included as an additional parameter while assessing the quality of an institution.

4. In the knowledge-based economy, emphasis is being laid world over to produce more number of PhDs in science & technology. As a national responsibility, efforts are being made by CSIR to augment the number of PhD by identifying and nurturing budding young scientific talent and providing financial support in the form of Junior Research Fellowships (JRF) through National Eligibility Test (NET). CSIR provides financial support to more than eight thousand students at any given time to pursue PhD in universities and R & D institutions. During 2007-08, the number of fellowships awarded by CSIR was increased by fifty percent (50%) to enlarge the pool of students pursuing PhD. India has significant
advantages in the 21st century knowledge race. It has a large higher education sector – the third largest in the world in student number after China and the United States and highest number of young people. Empowerment of creative young minds to carry out research guided by curiosity and new ideas will prepare India to meet the challenges of the 21st century. Thus concerted efforts are required to further increase the number of fellowships to pursue doctoral research.

5. Assessment of demographic variations in basic science education on the basis of CSIR NET indicated significant differences across different states. Institutional learning on the pattern of successful institutions could further facilitate S&T capacity development. Vast differences in efficiency scores across different states and union territories indicate the need for directed efforts to upgrade the overall standard of basic science education in the country. A transparent, accountable, discipline-specific quality assurance system would ensure the best educational outcome. Emergence of Delhi & Himachal Pradesh with contrasting demographic profiles could serve as a role model for other states to imitate.

5.4 Suggestion for future work

The important suggestion for further research work in this area:-

Capacity development is an important component for furthering scientific research in the country. Numerous schemes of government departments have been initiated to attract, nurture and retain young researchers in the field of scientific research. The strategies for the implementation of schemes must be based on the effectiveness of the capacity building intervention. The results of
the study can be explored further with respect to the out-turns of doctoral degrees, research productivity in terms of research papers published and patents filed/granted which are important bibliometric parameters to determine the S&T output of country. A study in regard to enrolment and selection of women candidates in CSIR NET and regional disparities needs to be explored.

5.5 Limitation of the study

Though our study essentially focused on capacity building through NET conducted by CSIR (through which majority of the fellowships to pursue doctoral research in basic sciences are given), similar data pertaining to other fellowship schemes, such as National Board for Higher Mathematics (NBHM), Joint Entrance Screening Test (JEST), DBT-Junior Research Fellowship program, ICMR–Junior Research Fellowship Exam etc., could have been utilized to substantiate the research findings.

5.6 Implication of the study and concluding remarks

The study pertains to the performance of universities and evaluation of demographic efficiencies in fulfilling S&T Capacity-building goals on the basis of CSIR research fellowship scheme (NET). Selection profile of NET qualified candidates in the ten exams indicates that 60% of the qualifying students are only from 32 universities. Further same set of universities repeatedly showed their presence in terms of selections as well as in enrolment of candidates.

Though the ICT infrastructure and other learning facilities are adequately available in all the universities, the least performing universities are required to improve upon curriculum design, quality of teachers and promotion of research.
Further, to improve the efficiency of different states across the country in fulfilling S&T capacity building goals, Delhi and Himachal Pradesh with contrasting demographic profiles could serve as a role model for other states to imitate.