

# Research Cluster in Engineering Education and Human Resource Development

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## Abstract

The Ministry of Human Resource Development envisaged a research cluster in engineering education in the 1980s under United Nation's Development Project in technician education development. Many initiatives have been taken to institutionalize research in engineering education by the Technical Teachers Training Institutes (now National Institutes of Technical Teachers Training and Research) in Bhopal, Chandigarh, Chennai, and Kolkata. These four institutes have grown into the Centers of Excellence in Engineering Education and assisted the project polytechnics, State Project Implementing Units, National Project Implementing Unit and World Bank. They offer part-time and full-time interdisciplinary Ph.D. programs in curriculum evaluation, improvement, instructional design, improvement of diploma, degree and postgraduate programs, educational administration, educational management, institutional development, human resource development and management.

**Keywords:** Research Cluster in engineering education, interdisciplinary research, and project-based research

## Introduction

In 1960s four Technical Teacher Training Institutes (TTTIs), in Bhopal, Chandigarh, Chennai, and Kolkata had been established as regional institutes by the Ministry of Education, Government of India to improve the polytechnic faculty members, develop industry-relevant curricula, prepare instructional packages, and provide assistance to states in the region in planning state relevant diploma programs. These institutes had collaboration with the Colleges

of Education in the UK through British Council and other colleges in Europe. These institutes are autonomous and governed by a Board of Governors. They offer long-term interdisciplinary teacher training programs and short-term courses in content updating, pedagogy, educational technology, educational management and curriculum development. The government of India evaluates the achievement of these institutes once in ten years and implemented the suggestions. These institutes are also so assisting the Government of India in planning and implementing direct central assistance to improve the technical education. In the 1990s these institutes started offering research programs based on the direction from the Ministry of Education. In 2003, the TTTIs are elevated to National Institutes of Technical Teachers Training and Research (NITTTRs).

## Objectives

1. Identify the needs of the research clusters in the engineering education.
2. Identify some well performing global research clusters in the engineering education
3. Suggest the formation of research clusters in Indian engineering education

## Research Questions

What are the advantages of establishing the research clusters?

What are the impediments in planning research clusters in engineering education?

What are the cognitive strategies to successfully establish research clusters in the Indian engineering education?

### **Needs for Research Clusters**

If the research methodology is same and the research instruments are developed based on the objectives or terms of reference,

- If the research project is to be undertaken simultaneously throughout the nation within a fixed period
- If the competent resource persons are readily available in various institutes who have professional expertise in the area of research
- If the research problems area applicable in various regions of the country
- If the cost of the expenditure is to be minimized without sacrificing the quality of the work
- If the research methodology is to be same and research instruments are to be developed based on the objectives or terms of reference.

Then the research clusters could be constituted and the research workers could be entrusted to undertake the project under same terms and conditions. This mode is more suitable for many development projects implemented in the various parts of the country under international development agencies like World Bank, UNDP, ILO, and UNESCO.

Also, national projects in engineering education, agricultural education, health education, vocational education and forestry education could be successfully completed within a fixed time.

### **Literature Survey**

Many universities in UK and USA have established research clusters. The Universities are structured into a number of clusters, to encourage a network form of organization for collaboration and engagement and focus on international and engaged research (University of Birmingham).

### **South, West and Wales Doctoral Training Partnership (SWW DTP) Research Clusters**

Clusters have been developed around themes and questions of wide resonance that will enable cross-dialogue and knowledge exchange. The salient points are:

- SWW DTP research clusters are student-led, with academic support and advice
- Students can get involved with multiple clusters
- The clusters are adaptive to the needs of each cohort and they encourage students to set up new interdisciplinary clusters based on their research interests.
- Students engage in discussion and debate across institutional boundaries using SWW DTP's research cluster Facebook group and at the biannual cohort days

### **Major Research Cluster Areas of College of Engineering of the University of Akron, Ohio, USA**

- Advanced Materials (engineering/research/research-clusters/advanced-materials.dot)
- Biotechnology/Biomedical
- Chemical Technology and Advanced Combustion
- Clean/Renewable Energy
- Computers , Sensors, Devices and Instrumentation
- Corrosion, Systems Health Monitoring, and Reliability
- Structural , Hydro and Geotechnical
- Systems, Design, and Automation

### **Research Clusters of the University of Houston**

- The University of Houston's research clusters are multidisciplinary, challenge-based groups of investigators that include and draw on the strengths of existing research centers, institutes and laboratories within multiple academic departments and colleges

- The Houston University has adopted the concept of research clusters to take advantages of the interrelationship of research areas
- Clusters are faculty-driven, multilevel frameworks that connect researchers with expertise in various disciplines in a multi-campus system with industry partners and funding agencies. They provide an inclusive foundation for collective scholarly activity and foster the sharing of ideas.
- Each cluster is to develop a strategic plan, which will include cluster hiring and investment in core facilities that further enliven the research enterprise and ultimately, enrich the student experience.

### **Inferences**

Each research cluster focuses on the selected areas of research and also the students are very much assisted in conducting in-depth research.

The concept of research cluster would help the NITTTRs to develop interdisciplinary research center around the engineering education.

Their contribution would assist the growth of knowledge capital.

### **United Nation's Development Project in Technician Education**

#### **Planning for the Faculty Development in Research under UNDP**

During 1978-1982, the technician education institutes and TTTIs were developed through UNDP. One of the focus areas of development is research in engineering education. The faculty members from the four TTTIs were deputed to undergo faculty development programs in educational research at Ohio University, Columbus, Illinois University-Urbana-Champaign, and Indiana University, Bloomington. A core team was created in engineering research in all TTTIs. In addition, all these institutes established an Educational Research Department. The faculty started offering short-term courses to the polytechnic faculty members under the Quality Improvement Program of the MHRD. Later

all these institutes started postgraduate programs in engineering education by affiliating with the state universities. Educational research is one of the courses offered to the students.

### **Recommendation of the Bhattacharya Committee for Fellowship Program**

In 1991, the Bhattacharya Committee constituted by MHRD recommended to offer fellowship programs in the engineering education. Also, the Planning Commission suggested research oriented programs and projects.

### **Major Research Clusters of TTTIs**

- Curriculum Development Research Cluster
  - Conducts research studies in industry specific, flexible, competency-based diplomas, undergraduate degrees and postgraduate degrees in engineering and technology
  - Assists the states in refining their existing engineering programs
  - Conducts global faculty development programs
  - Assists the project polytechnics to plan state resource based new diploma programs
- Engineering Faculty Professional Development Programs
  - Evaluates the needs of the various cadres of the polytechnics, and the engineering colleges and plans appropriate faculty development programs to upgrade their competencies
- Sponsored Research Cluster
  - Undertakes sponsored research projects under various ongoing development projects in engineering education
- Institutional Development Research Cluster
  - Assists the states in preparing detailed project proposals for getting the project assistance from the World Bank
- Outreach Research Cluster
  - Bids for global projects under various international development agencies for offering academic consultancy

- Bids for undertaking various employee development projects from various ministries
- International Cooperation Research Cluster
  - Cooperates with UNESCO, UNDP, USAID, and World Bank for offering faculty development projects under ongoing projects

### **World Bank assisted Short-term Program in Engineering Education Research**

In 1999, six senior faculty members have been deputed to undergo customized training program in Educational Research at the College of Education of the University of Illinois, Urbana- Champaign, USA. This has motivated the faculty to plan high-end research programs.

### **Establishment of Interdisciplinary Doctoral Program in Engineering Education (Ph.D.)**

All the NITTTRs have established interdisciplinary Ph.D. programs through affiliation to the state universities. The full-time program could be completed in three years and the part-time program could be completed in four years. Many faculty members of NITTTRs have registered for part-time Ph.D. programs.

The university advertises for admitting the students into the Ph.D. programs. The students have to pass the entrance examination with minimum 60% marks for qualifying for admission. 50 % of the marks obtained by them in their postgraduate degrees are considered for the selection. The students have to appear for the interview and 50% of the marks are to be obtained for their admission.

### **These Institutes publish the following Research Journals:**

Journal of Technical and Vocational Education, NITTTR-Chennai

Journal of Engineering, Science, & Management Education- NITTTR- Bhopal

Journal of Engineering & Technology Education, NITTTR-Chandigarh

### **Research Studies Sponsored under the World Bank assisted Project in Technician Education Tech Ed I and II**

The four research clusters were entrusted to conduct the following research studies:

- Analysis of Quarterly Progress in all the project components of the states
- Half yearly Progress Report for deliberation before the Joint Review Mission of the World Bank and MHRD
- Research Studies on the Employment of Polytechnic Pass outs in the Project States in all the four regions
- National Report on Employment Status of Polytechnic Pass outs in India ( Tech Ed I and the II States)
- NITTTR Chennai has won and successfully completed technical instructor's development program for the Council for Vocational Education and Training (CTEVT) Kathmandu, Nepal under the ongoing Asian Development Bank (ADB) assisted the project in 1996.
- NITTTR Chennai successfully prepared faculty development programs under United Nations Development Program (UNDP) for Bhutan in 1997.
- NITTTR Chennai has won and successfully developed M.Sc (Forestry) curriculum, guidelines for Accreditation, and norms for the faculty development in forestry for the Indian Council for Forestry Research and Education (ICFRE) under the ongoing World Bank assisted Project in 1999.

### **Publication of Instructional Materials, Video Programs, and Digital Multimedia Learning Packages**

All the TTTIs published needed learning packages (Textbooks, Drawing Manuals, Workshop Manuals, Item Banks, Program Instruction Booklets, Guidelines for Project Based Learning, Team Teaching, and Educational Video Programs. Selected books were published through reputed publishers like Oxford University Press, McGraw-Hill Publishers, and Chand & Co.

### **Research Studies Sponsored by the World Bank Assisted Project Tech Ed III for the North Eastern States**

The TTTIs are contracted as Academic Consultants for developing the faculty through institution-specific customized programs in the following areas:

- Content updating of the faculty members in the Emerging Areas
- Curriculum Evaluation and Improvement
- Curriculum Design in the Emerging Areas
- Autonomy
- Computer application
- Continuing Education
- Tracer Studies of the Polytechnic Graduates

### **Sponsored Research Studies in the First Phase of the World Bank assisted Project in Technician Education III for the North Eastern States**

The following research projects were awarded to the four TTTIs by the Ministry of Human Resource Development in consultation with the World Bank authorities:

The Nodal officers of these four formed focused research teams and prepared to measure instruments and deliberated among the research cluster institutes and project polytechnics. Data have been collected, analyzed and draft reports were discussed with the State Project Implementation Units. The edited final reports were completed and presented to the National Project Implementation Unit for further action in consultation with the project director. The details of the research projects are:

- Progress of various components under the World Bank assisted project and strategies for completion as per the schedule
- Status of Women Technicians and Women Faculty and Staff Members in the project polytechnics
- Assessment of the Continuing Education of Skilled Workers of Nearby Institutions and Other Organizations
- Study on the Utilization of Institutional Resources like Space, Equipment, Libraries, Learning Resources

- Study on the Modernization of Laboratories
- A Study on Continuous Improvement in Efficiency and Effectiveness of Teaching – Learning Process in the Project Polytechnics
- A Strategic Plan for Resource Generation through Transfer and Greater Societal Interaction
- Study on Current Employment Status and Job opportunities for Polytechnic Graduates in the existing and new disciplines in the project states

The research reports were also deliberated before the Joint Review Meeting conducted by the National Project Implementation Unit. In addition, a seminar was organized for the detailed presentation before the representatives of project states. Strategies were worked out for improving the implementation of the project.

### **Second Phase Research Studies**

As per the Detailed Project Implementation Plan, the institutes in the research cluster were awarded the following research projects:

- Research Study on the Equipment Utilization in the project polytechnics
- Statewide Consolidated Report on the Equipment Utilization
- Impact of World bank Assisted Project in Technician Education III on the region covered by the polytechnics
- Statewide Consolidated Report on the Impact
- Sustenance of Project Innovations by the Polytechnics

### **Utilization of the Impact Studies**

The states have planned to use the modern resources created in the project polytechnics. Many states (Tripura, Arunachal Pradesh and Union Territory of Andaman and Nicobar Islands) have established Engineering Colleges in the project polytechnics using the infrastructure and resources. New diploma programs in the emerging technologies were established. Based on the “Look East Policy” of the government, National Institute of Technology in each project state has been established by the Government

of India. Additional polytechnics were established to create human capital to meet the demands of the proposed industries. The graduates also got very good employment in other industrialized states.

### **Cooperative Faculty Development Programs with CPSC and UNESCO**

Many TTTIs are the associated centers of Colombo Plan Staff College (CPSC) for Technician Education, Manila, Philippines and UNESCO's Asian Center for the Educational Innovation for Development (ACEID) Bangkok, Thailand. These TTTIs undertook many research-based faculty development studies and workshops which are sponsored by UNESCO and CPSC. Many senior faculty members have become the faculty consultants and Directors of CPSC.

### **Upgradation of TTTIs as National Institutes of Technical Teachers Training and Research**

The evaluation committee headed by Dr. Indiresan, Former Director of IIT Madras, after studying the achievement of TTTIs recommended upgrading these institutes to national institutes. The Committee further recommended that by utilizing the competencies of the faculty of these institutes to develop the engineering college teachers. The MHRD has upgraded them as national institutes.

These Institutes bid and own the Faculty Development Programs under International Development Agencies like Asian Development Bank, UNDP, UNESCO and World Bank.

### **Global Engineering Faculty and Executive Development Programs sponsored by Ministry of External Affairs and Ministry of Finance**

NITTTR Chennai has become a leader in developing and implementing global engineering faculty and executives' development programs under Special Commonwealth African Assistance Programme (SCAAP), Indian Technical and Economy Cooperation (ITEC) program of the Ministry of External Affairs and under Technical Cooperation Scheme of Colombo Plan of the Ministry of Finance. This institute plans around 10 medium-term (6-8 weeks) development programs in curriculum

development, engineering education planning, educational video production, water testing, sustainable development, GIS, and Women in development etc. Around 150 participants from Asia, Africa, Central and South America, Eastern Europe and Oceania are attending these courses per year.

### **Interdisciplinary Ph.D. Programs in Engineering Education**

NITTTR Chennai has become one of the leaders conducting the interdisciplinary research programs by guiding research scholars from the polytechnics, engineering colleges, and industries. They come with research proposals and they are assisted in refining the research problems and guided to select appropriate research methodology, develop instruments, select appropriate samples, collect feedback/ information, analyze the feedback, and verify the hypotheses using various SPSS tools and draw conclusions.

#### **The following are the broad research areas:**

- Curriculum evaluation against the current needs of the employers in engineering, technology, and management
- Developing new curricula at diploma, bachelor degrees and postgraduate degrees in engineering and technology to meet the challenges of fast growing Indian industry
- Evaluating the institutional development processes and preparing suitable strategies to overcome the barriers, bottlenecks
- Developing faculty development methods programs in emerging technology
- Analysis of educational issues due to WTO
- Analyses of globalization of engineering education
- Impact of environmental problems
- Quality improvement and internal quality assurance in tier 2 engineering programs

Around 60% of the doctorates of the interdisciplinary programs in engineering education reached the level of the directors, deans, and principals of the engineering colleges and management colleges. The rest of them have got the Associate Professor post in the engineering colleges. Many of the doctorates

from the industries have reached the level of vice-presidents in the industries and trainers in the corporate.

### **Expected Institutional Development in the Future**

It is expected that these four institutes would be elevated to the cluster of Institutes of National Importance so that they can bring more innovations under the new contexts like “Make in India”.

### **Major Contributions in Engineering Education Research by these four Research Clusters**

- Successful academic consultancy programs offered to many IDAs
- Developed around 0.5 million faculty members for engineering education over a period of 52 years
- Offered cooperation to various International Development Agencies like UNESCO, UNDP, USAID and World Bank
- Trained international faculty members from more than 100 countries through the assistance of the Government of India
- Successfully assisted engineering education through industry-relevant curricula and instructional packages
- Cooperated with various private industries in training their employees
- Contributed to the knowledge capital in the engineering education

### **Advantages of Research Clusters**

- Dynamic process
- Cost effective
- Quick results
- High quality
- Reliable regional reports and consolidated national report in the shortest time

### **Impediments to Research Cluster Mode**

- Absence of competent research institutes and workers in all regions
- Projects are implemented in various periods

- The goals are varying from region to region
- Unapproachable regions
- Limited agreements of the project implementation

### **Summary**

Four NITTTRs have become lead centers like one stop center for developing engineering education. Till today no industry left India for want of creative technicians or engineers. The Huddersfield University, UK has complemented the contribution of these four NITTTRs.

### **Conclusions**

These NITTTRs would not only be elevated to the club of Institute of National Importance but also to the elite club of global institutes. Based on the success in creating a research cluster in Engineering Education in India, MHRD could plan many industry relevant research clusters in various State Technical Universities, Autonomous Colleges, National Institutes of Technology in collaboration with Ministry of Science and Technology, CSIR, Ministry of Industries, Ministry of External Affairs and Ministry of Finance.

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