

From Student to Software Engineer in the Indian IT Industry: A Survey of Training

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IT Offshore Outsourcing

■ **Offshore Delivery Model**

In Offshore Delivery Model, the entire project is accomplished at the service provider's offshore development centre, which is located in a different country

■ **Advantages of Offshore Delivery Model:**

- **Reduced Costs:** Advantage of low labour cost, which reduces overall costs drastically
- **Excellent Results:** Clients can get high quality work from the quality offshore resources
- **No extra Expense:** Client doesn't have to worry about the infrastructure needed to complete their task

IT Offshore Outsourcing-conti....

- Access to the Most Optimal Resources: Client can have access to the best possible technology, skilled manpower and equipments, depending on their budgets
- 24/7 Productivity: Work is not affected by time-zone difference

Impact of IT Offshore Outsourcing-Indian Scenario

- Economic Growth
- Technical and Non Technical Employment Generation
- Regional Development
- First Generation Entrepreneurships
- Social and Cultural Changes
- Increase in demand for skilled IT professionals & Likely to grow further
- Growth of IT education in India

New Initiatives for IT Education in India

- Opening of New Institutes for IT Education by Central Govt and State Government
- Emergence of New Private Institutes for IT Education
- Joint Public-Private Institutes established
- Five New Indian Institute of Technologies founded
- Eight New International Institutes of Information Technologies providing Undergraduate, Graduate and Ph.D. degrees established
- Total 1645 Engineering Institutes: recognized by University Grants Commission
- More than 400,000 students passing out in a year with IT degrees

Graduates not readily employable

- Despite opening of many New Institutes and large number of students passing out every year, the IT Industry is struggling to get students with high quality
- Graduates from academic institutes are not readily employable IT industry reports
- National Association of Software and Service Companies (NASSCOM) reported –only 25% are employable

Industry Response and Initiatives

Responding to the needs, IT Companies started conducting Trainings for fresh recruits

- Investment in IT education by IT industry was 3% of the total revenue in the year 2008-2009
- Top Five Companies Infosys, Wipro, TCS, HCL Technologies and Satyam-Mahindra invested \$430 million dollars in 2008 to train more than 100,000 entry-level engineers
- Companies have their own training Centres / Institutes.

Industry Response and Initiatives-contd...

- Companies collaborate with educational institutes
 - Curriculum Development
 - Course Design
 - Organize Events
 - Conduct Faculty Training
 - Supply Experienced IT Professionals as Visiting Faculty
 - Provide On and Off Campus training
 - Provide mentorship to students

Industry Response and Initiatives-contd...

- National Institute of Information Technology (NIIT) –established exclusively for training
 - Provides short-term and long-term courses for students as well as professionals
- Microsoft and HCL- have established more than hundred Centres of Excellence for training and certification in Microsoft technologies which can train up to 50,000 students

Motivation and Purpose of Our Study

- To understand the gap between the needs of IT industry and the graduates produced by the universities in India
- To understand how companies train their fresh recruits
- To know what type of technical training, behavioural training and IT-offshore-outsourcing related training is provided to fresh recruits

Research Questions

- The research questions we investigated in this study were:
 - What makes large chunk of fresh IT graduates of Indian Universities not employable vis-a-vis the needs of the IT industry in India?
 - What is the nature and blend of the technical, behavioural and IT offshore outsourcing training that fresh recruits undertake in IT companies in India?
 - What recommendations can be made to address the gap between the skills acquired during formal education and the needs of the IT industry in India?

Methodology Adopted for Our Study

- Visiting IT Companies and interviewing HR professionals and Training Managers of Large, Medium and Small size companies
- Interviewing fresh recruits
- Conducting Surveys about trainings:
 - One for HR Professionals/ Managers and
 - Another for Fresh Recruits

Human Resources Professionals / Managers' Survey

- Survey questionnaire was sent to 80 different IT companies out of which 32 companies responded
- Questionnaire was related to the following:
 - Background information of the responding companies
 - Statistics about recruitment of fresh graduates
 - Training to fresh recruits: Nature , Contents of Training and Duration
 - Comments on Education Adequacy of Fresh Recruits
 - Open Comments

Freshers' Survey

- Survey questionnaire was sent to 82 fresh recruits working for IT companies graduated from different Indian universities
- Questionnaire was divided into five parts as follows:
 - Background information of the participants
 - Their Work Experience
 - Training received as a fresh recruit: Nature , Contents of Training and Duration
 - Comments about their Education Adequacy and
 - Open Comments

Findings of Human Resources Professionals / Managers' Survey

- **Respondents of the Survey:**
 - Human resources managers, directors, training managers and vice presidents with detailed knowledge of their companies

- **Responding Companies**
 - 46.88% foreign multinational companies
 - 25% Indian companies
 - 25% Indian multinational companies and
 - 3.12% foreign companies

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Findings of Human Resources Professionals / Managers' Survey-contd...

- **Sizes of Responding Companies**

<u>Category</u>	<u>Number of Employees</u>	<u>Percentage</u>
Small	< 1000	46.88
Medium	< 10000	15.62
Large	> 10000	37.50

Application Domains and Projects

- The application domains of these companies varied from IT, Telecom, Healthcare, Finance, Information Security to Construction and Manufacturing
- Approximate distribution of categories of projects undertaken by these companies is given in the following table:

Projects	Percentage
Local Projects	13.27%
Offshore projects (employees based at an Indian site)	64.42%
Offshore projects (employees based at a site outside India)	22.31%

Findings-Trends in Recruitment

- 86.95% of the respondents reported that the number of applications from freshers had increased significantly in the last three years
- Distribution of sizes of companies and the applications received by them in 2008 from fresh graduates is given in following table. More than 60% of these applicants were Computer Science graduates

Company size	Approx. Number of applications received
Large	> 20000
Medium	>10000
Small	>1000

Findings-Degrees and Designations

- Degrees held by Fresh Recruits:
 - B.Tech in Computer Engineering and IT
 - Master of Computer Applications (M.C.A.).
 - M.Sc. (Master of Science in Computer Science)
 - M.Tech in Computer Engineering and IT
- Designations Assigned to Fresh Recruits:
 - Software Engineer (51.72%)
 - System engineer (10.34%)
 - Associate engineer (10.34%).
- Reasons of newly hired graduates for continuing in their companies:
 - Learning opportunities (65%)
 - Interest of the job(15%) and Reputation of the company(15%)

Findings-Nature of training to fresh recruits

- Reason for Conducting Training
 - To polish the students' theoretical skills
 - To provide them with a practical baseline and
 - To learn about company-specific 'practices and culture'
- Conduct of Training
 - Job shadowing
 - Online courses
 - Lectures by instructors
 - Interactive learning with instructors
 - Graded team work
 - Graded individual work
- Average Duration of Training: 18 weeks
- Training Faculty: Mixture of internal and external faculty
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Findings- Technical Training

Topic	Count	Average Ranking	Total ranking
Programming languages	17	8.867	151
Databases	16	8.067	129
Information Security	9	10	90
Operating systems	13	9	117
Design	13	7.462	97
Testing and QA	16	7.625	122
Specific tools	15	7.933	119
Software process	18	7.706	138
Configuration management	15	7.267	109
Web programming	13	6.538	85
Networks and Data Communications	11	5.636	62
Distributed programming	9	6.444	58
Requirements	16	7.125	114
Version control	14	7.706	108
Project management	8	5.625	45

Findings: Programming Languages and IDEs Covered in Training

- Companies focus on Core Java, database programming, J2EE and
- Web Programming (e.g., ASP, JavaScript, PHP)
- Languages such as Python and Ruby are not covered because they are not widely used
- IDEs covered in Trainings:
 - Eclipse is the IDE, covered by the highest number of companies, followed by JBuilder and Visual Studio
- Duration of Technical Training:
 - Minimum – 2 weeks
 - Average –18 Weeks
 - Maximum – 24 Weeks
 - HR Professionals expressed lack of coverage of tools

Findings: Behavioural Training

- 78.95% companies provide behavioural training to fresh recruits
- Average duration of the training: 6-7 day
- Following topics are included:

Topic	Count	Average Rank	Total Rank
Team work	15	8.730	131
Communication (oral)	14	8.357	117
Behaviour in business settings	13	8.150	106
Behavior with clients	11	8.270	91
Communication (written)	11	8.360	92
Leadership	9	7.220	65

Findings: Training related to IT Offshore Outsourcing

- 21.05% companies provide training related to IT offshore outsourcing
- Average Duration: 1-2 days
- Topics included
 - Culture
 - Socialization
 - Collaboration tools (Wiki, Version control etc.)
 - Foreign language

Findings: Education Adequacy and Comments-Technical

- What should be added to the curriculum that would better equip the fresh graduates for their first job?
- The responses to this question can be summarized in three categories viz. technical, behavioral and general
- Technical
 - Basic Programming Skills: Deeper understanding of data structures and algorithm is lacking
 - Ability to apply the knowledge to a new problem domain is not so developed
 - An integrated approach towards subjects/topic taught is required
 - Comprehensive and integrated understanding of following subjects: computer architecture, operating system, Compiler-Linker and High Level Programming Languages.

Findings: Education Adequacy and Comments- Technical-Continued...

- Deeper understanding and practical experience of programming on one particular Operating System (either Windows or Unix or any other one).
- Deeper and practical knowledge of system software (Compiler esp. code generation, Linker, Loader, Assembler)
- Deeper understanding of relationship between high level languages (like C/C++) and low level languages (assembly language)
- Design of Programs: Students should be taught to think of multiple ways of solving a problem. They should develop the ability to think of various approaches towards solving a problem and evaluate and decide among these approaches

Findings: Education Adequacy and Comments –Behavioural

- Some of the companies were of the view that soft skills including oral and written communication skills should be part of curriculum. Only one company mentioned that there should be an intercultural awareness

Findings: Education Adequacy and Comments -General

- One great skill that academy should impart is 'Learn to Learn'
- There should be emphasis on quality and knowledge of what it means by doing a complete job

Findings: Freshers' Survey

Respondents of the Survey and their backgrounds

- The questionnaire was sent to 82 fresh appointees working for IT companies having 0 to 3 years of working experience out of which only 46 have filled in the questionnaire and the survey results are based on their responses
 - 44.26% had B.Sc. degree in Computer Science between 2003 to 2006 and
 - 26.23% had General B.Sc. degree (with or without CS) between 2003 to 2006
 - 70.49% of these have "Master of Computer Applications" between 2006 to 2009
 - 19.67% have received their M.Sc. Computer Science degree between 2006 to 2009

Findings: Trends in Recruitment

- For 90.38% of the participants, it was their first job
 - 34.62% of the participants worked for foreign multinational companies,
 - 26.92% for Indian multinational companies,
 - 25% for Indian companies and
 - 11.54% for foreign companies
- Most participants chose the company they were working, for Learning opportunities and its reputation
- Participants worked for
 - Offshore customers (71.17%) or
 - Local Indian customers (26.65%)
- Title in the company
 - Software engineer (53.85%) or
 - Developer (11.54%)
 - Rest were programmers, system engineers, associate engineers, analysts etc..

Findings: Software Engineering Education

- Most participants (80.33%) had SE course during their education in college/university
- Software engineering courses of the participants covered the standard topics with an emphasis on software process, testing and design, followed by implementation and requirements, and then quality assurance, with teamwork and communication being least emphasized
- This seems to show that software engineering is mostly taught from a theoretical point of view.

Findings: Work Experience of Participants

- The respondents worked under different types of company ownerships. These included Indian companies, foreign companies, Indian multinational companies or foreign multinational companies. The distribution was as follows:

Type of Company	Percent of respondents working for companies
Product Developing company	34.62
Service Providing company	26.92
Both	34.62
Govt.	1.92

Findings: Nature of training as a fresh recruit

- 90.20% participants had undergone training
- 9.80% did not undergo any training; the reason probably could be that they had some work experience when they joined the company
- Internal personnel conducted the training
- Most common types of training:
 - Interactive learning with instructors and instructor-led lectures
- The models of training included
 - Continuous mentoring (32.43%),
 - Mandatory continuous training (25.68%) and
 - Mandatory formal upfront training (22.97%)

Findings: Technical Training

- 71.43% of the fresher recruits had undergone technical training
- Topics covered and the rankings assigned to various topics:

<u>Topics</u>	<u>Count</u>	<u>Total of Ranks</u>	<u>Average Rank</u>
Programming languages	29	204	7.034
Specific Tools	21	136	6.476
Web Programming	19	135	7.105
Databases	20	121	6.05
Design	20	120	6
Software Process	13	117	9
Configuration management	20	103	5.15
Networks and Data Communications	20	110	5.5
Requirements	19	109	5.737
Testing & QA	18	104	5.778
Project Management	18	100	5.556
Operating Systems	22	100	4.545
Information Security	18	95	5.278
Version Control	16	82	5.125
Distributed Programming	16	70	4.375
Total	289		

Findings: Programming Languages

- Topic of Programming languages / web programming was given the maximum importance in the trainings of the participants
- More participants had undergone training in Core Java, Web programming languages and Database programming languages, compared to other programming languages

Core Java	16
Web programming Languages (ASP/JSP/JavaScript/PHP/PERL/XML/ODB C/JDBC etc.)	16
Database Programming Language (SQL/PLSQL)	16
C++	10
J2EE	10
C#	9
C	9
Visual Basic	3
Main Frame Languages(JCL, COBOL)	1
Python	0
Total	90

Findings: Technologies Covered during the training

- 41.8% of the participants had received training in Java Technology
- 26.47% received .NET technology training
- According to survey results, the maximum number of participants had undergone training in Eclipse IDE, followed by Visual Studio, Rational tools
- This indicates that Eclipse is the most popular IDE in the industry
- Duration of Technical Training: 4 to 24 Weeks

Findings: Behavioral Training

- 50% of the participants had undergone behavioral training as a part of their training during their initial recruitment
- Duration of this training varied from half a day to 20 days, but the average duration was 4.5 days.

<u>Topic</u>	<u>Count</u>	<u>Total Ranking</u>	<u>Average Ranking</u>
Team work	20	155	7.75
Communication (oral)	20	150	7.5
Behavior with clients	17	137	8.059
Communication (written)	18	132	7.333
Behavior in			

Findings: IT Offshore Outsourcing related Training

- 9.76% of the participants had undergone this training which included
 - Socialization
 - Foreign Culture
 - Collaborative tools (wiki, version control etc.)
 - Foreign Language
- The duration of IT Offshore Outsourcing related Training varied from one day to five days.

Findings: Education Adequacy and Comments

- 50% expressed their satisfaction about their curriculum
- 28% were of the opinion that their curriculum was not adequate
- Remaining felt that it was adequate only to some extent and needed modifications
- The views of fresh recruits are summarized in three categories viz. technical, behavioral and general

Views of fresh recruits :Technical

- Educational institutions stress many subjects without giving in-depth knowledge on any particular one and they focus only on programming
- More emphasis should be placed on design principles
- More emphasis should be placed on the architectural design of software
- A unique but relevant comment about the lack of attention to maintenance was reported: "My work is to provide support to applications. Curriculum lacked documentation / maintenance."

Views of fresh recruits :Technical continued...

- Lots of technologies commonly used in industry are not introduced during their studies.
- Students should be encouraged to do real-life projects in collaboration with the industry
- Software engineering processes should be followed, as well as the use of configuration management and version control
- In the last semester, industry experts should be invited to coach and guide the students about their professional life

Views of fresh recruits : Behavioural

- “No focus on communication skills at college which unfortunately is one of the key attributes to enable a student to make herself/himself sellable in the market”
- “Communication skills should be sound for the job. For communication skills some GD (Group Discussion) should be conducted”
- “What, I felt, was lacking in the system is extra curricular activities like debates and other activities which also play an important role to improve confidence in a student and also to think interactively”

Views of fresh recruits :General

- Syllabus should be revised every two to three years according to the current requirements of the industry
- Proper infrastructure should be made available to students for providing appropriate training in educational institutions

Conclusion and Recommendations

- A visible gap is being formed between the types of graduates that Indian universities turn out and the current needs of the IT industry in India
- Our sample size was small but our conclusions and recommendations are universally applicable.
- Similar situation also exists throughout the world. This has also been substantiated by the well known computer scientist, Prof. Bjarne Stroustrup in his recent article in Communications of the ACM Vol. 53 No. 1, Pages 40-42, "What Should We Teach New Software Developers? Why?", who has advocated for Fundamental changes in computer science education to better address the needs of industry. The Problem: In many places, there is a disconnect between computer science education and what industry needs.

Recommendations-Continued...

- As the first designation of freshers in the IT industry is “software engineer”, software engineering topics (e.g., process, requirements, design, development, testing and quality assurance) should be emphasized in the curriculum rather than programming
- Software engineering should be taught by incorporating real-life experience of offshore outsourcing for students to better equip the students for their first job

Contd...

- We have implemented different models of collaboration where teams of students, globally distributed in the US, India, Thailand, Cambodia and Senegal worked together on the development of software systems for clients
- These settings permitted students to develop technical skills, leverage their soft skills and be exposed to engineering, communication, project management and socialization tools to support the distributed development of software systems.

Thank You All

- Thank You All for Your Time and Patience