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An Empirical Study on the Impact of Industry Supported Courses in enhancing the Graduate Outcomes

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Abstract:
The collaborations between industries and academic institutes play a vital role in developing a strong and skilled workforce. The major advantages of industry institute collaboration include:

- Industries gain work-ready talent with specialization in the respective domains.
- Institutes and Universities have the benefit of opportunities to work on the state of the art technologies with appropriate mentorship from industrial experts.

The department of Information Technology at Thiagarajar College of Engineering, Madurai has explored the possible venues for Industry Institute Collaboration in all aspects of Teaching Learning Process. Industry institute interaction is strengthened through various activities like establishing industry supported laboratories, offering one credit courses/certifications to the students, inviting industry experts for conferences /workshops /seminars/ guest lectures, faculty training by industry personnel, in-plant training, industrial visits and industry internship for students. This research work aims at analysing the impact of industry supported courses in enhancing the graduate outcomes of the learners. The department has organized four to five courses on an average in an academic year in association with leading industries. The enhancement in learning outcomes is assessed through two major factors namely the enhancement in employability of the graduates and quality of the final year projects. The extensive data analysis for the past three academic years have shown significant increase in the placements in dream companies, increased level of participation in national/international contests and in increased number of students' research publications. It could be inferred from the student satisfaction report that the learners are satisfied with the learning experience created by the industry supported courses to a greater extent .

Keywords: Industry Institute Collaboration, Program Outcomes, Assessment of Program Outcomes, Continuous Improvement

1. Introduction

India is ranked 109 among 145 countries with a score of 3.06 in knowledge economic index [9]. Industry Institute Interaction is identified as a promising avenue in improving the global knowledge index. The competition among industries has risen to a greater extent due to the advent of globalization and the digital economy. Industries have now started looking into partnering with academic institutions for qualified workforce. At the same time, young graduates of the country are to be given industrial exposure during their graduation to enhance their technical skills to compete in the global employability market. Though industries and institutes have been collaborating over the years, the need for intensified strategic partnerships has been realized to a greater extent in the present scenario. The Government of India has emphasized on various collaborations in the Make in India program. The abundance of manpower in India has to be transformed into a skilled workforce. Strengthening of Industry institute collaboration seems to be a promising solution for speeding up this transformation. There exists a win-win partnership in all aspects of technological development, starting from conceptualization to commercialization.

2. Related Works

Significant efforts have been made in promoting the collaboration between industry and academia all over the country. Ravena et al. (2014) have identified the various types of interactions between an industry and institute maintained in India. The increasing demand for the collaboration has been emphasized in all aspects. The requirements from industry and the requirements from the academic institution are clearly stated. Many of the premier institutes in India have a Industry Institute Interaction cell which primarily focuses on strengthening the collaboration for deriving mutual benefits. The possible modes of interaction could be

- Internship/ in-plant training for final year and pre-final year students in industries
- Technical consultancy by the faculty to industries.
- Industrial testing by faculty at industrial sites or in laboratories.
- Joint research programmes and field studies by faculty and people from industries.
- Joint participation in Workshops, conferences and symposia
- Collaborative degree programmes.
- Establishment of R&D Laboratories sponsored by industries at the Institute.

The experimental study by Hebbar et al., (2014) has reported that industry institute collaboration have significant influence on research & innovation, teaching & learning, employability and knowledge transfer in engineering colleges in Pune region. The most significant method of knowledge transfer was found in the training of students by industrial personnel, recruitment of personnel from engineering institute, contract research on behalf of industry, research collaborations and use of industrial equipment in engineering institute's labs. The impact of industry institute interaction in promoting taching learning experience has been analysed by Srinivasa et al., (2014). It has been reported that interactions with the industries can happen for various reasons including curriculum design and development, training and skill development, basic and applied research, technology development and knowledge transfer. Nandi et al, (2016) have emphasized the importance of Industry institute collaboration in an engineering degree program by analyzing the impact of organizing a technical event on circuit makers in association with Texas Instruments in promoting team building and product building skills. The impact of industry institute collaboration in promoting entrepreneurship has been studied by Ramesh et al (2016). Sample groups of professional students and their inclinations towards entrepreneurship - on the basis of behavioural traits, passion, drive, risk taking capacity are tested by administering structured questionnaire to them. The analysis of how effective is the inclusion of Industry-Institute-Interaction in the academic curriculum is made through the questionnaire. The role of industry -institute interaction to promote education and entrepreneurship has been analyzed by Padma et al. (2016). Jones et al., (2017) have clearly emphasized the need for industry institute interaction to bridge the skill gap and to increase the employability of graduates in developing nations. It could be inferred from the literature that there is a very limited work on assessing the impact of industry supported courses exclusively in enhancing the graduate outcomes. Also, it could be inferred that well defined policies and procedures for gap analysis in the curriculum and industrial needs, Standard Operating Procedure for course offering by the industrial experts are also very limited. This research work explores the possibilities of industry collaboration with academia for course offerings and provides a systematic methodology for analyzing the impact of industry supported courses especially in enhancing the employability and quality of projects.

3. Research Objectives

The motivation for research is supported by the following research questions:

A. What is the impact of offering industry supported courses in enhancing the employability of the graduates?
B. What is the impact of industry supported courses in enhancing the quality of final year projects in undergraduate curriculum?

4. Materials and Methods

A. Design of Industry Supported Courses

Every department in the institute has special interest groups which focus on the key technologies domains of the corresponding discipline. Gap analysis has been conducted during every semester periodically to address the missing link between the curriculum and industrial trends by the members of the special interest groups. The feedback from alumni, recruiters, graduating students, faculty and program performance assessment committee are taken into consideration in the gap analysis process. The industrial experts are identified through the network of the institute and from various social networking sites. The proposal for collaboration is submitted to the industrial experts through the proper channel. After the proposal to offer a course has been accepted by the industry, one/two faculty members are identified as course designers from the institute. Periodical meetings are conducted with the industrial experts team to formulate the course design with well defined course outcomes. In general, the course is planned for a duration of 14 hours for one credit. Based on the nature of the course and volume of course contents, if required, it can be extended for a duration of 28 hours with two credits. A sample course design document for industry supported courses is available at https://tinyurl.com/achs93zs . The course design is then submitted to the board of studies and academic council for approval.

B. Content Delivery

Once the course has been approved in the academic council, the course is open for registration for the students during a specific period of time. The course is offered by the industrial expert in online/blended mode of learning. The methods for content delivery are chosen in accordance with the cognitive level of course

outcomes. A variety of instructional delivery methods like have been experimented to enhance the learning. Traditional teaching methods such as lecturing and demonstrations are supported with problem based learning, case studies and seminar presentations. While the expert from industry would be the primary resource person for the course, department faculty would be involved in designing courseware and assessment. The list of courses that were organized by the department in the last three academic years has been presented in the table 1. An industry supported course is limited to a maximum of two offerings only within which the expertise to offer the course independently by the department has to be developed.

Table 1. List of Industry supported courses offered during last three academic years

S.No	Course Name	Industry
Academic Year 2018-19		
1	14IT1Q0 Watson Analysis	IBM Bangalore
2	14IT1U0 Regression Techniques for Engineering Applications	Datalore Labs, Bangalore
3	14IT1M0 Augmented Reality	CDAC, Bangalore
4	14IT1P0 Applied Predictive Modelling using Python	CTS,Coimbatore
5	14IT1T0 Enterprise Application Development using SPRING	Pivotal Inc, Bangalore
6	14IT2C0 Offensive Security	Symantec Corporation, Chennai
Academic Year 2019-20		
1	14IT1H0 Virtualization Tools and Techniques	CDAC, Chennai
2	14IT1R0 Mobile Application UI Test Automation	Zebra Technology Solutions, Bangalore
3	14IT2E0 Secure Network Edge and Mobility Solutions	Symantec Corporation, Chennai
4	14IT1Q0 Watson Analytics	IBM Bengaluru
5	14IT1V0 Building Scalable Applications with Micro Services	Sequoia Consulting Group, Chennai
Academic Year 2020-21		
1	18CS1C0 Containerization Technologies	VMWare Software Ltd
2	18IT2B0 Penetration Testing Methodologies	Spider Labs, Singapore
3	18IT2A0 Multiplatform Mobile Application Development	Buddi AI, Chennai
4	18IT 2D0 Datascience and AI Applications	Great Innovous, Madurai

C. Assessment

Course outcomes of the industry supported courses are assessed through continuous assessment tests and terminal examinations. The assessment items are chosen in accordance with Bloom's taxonomy and are designed by the course faculty at the institute and industrial expert team. Course outcomes at higher cognitive levels are assessed through mini-projects, case studies and presentations. Exclusive rubrics are designed to assess course outcomes at higher cognitive levels.

5. Results and Discussion

While there are many definitions available for employability, some key skills are essentially used for measuring it. The key skills expected to be possessed by a graduate for employment are critical thinking, communication skills, professional ethics and morality, entrepreneurial skills, personal quality. Along with these generic skills, discipline specific skills, say for example Programming skills for computer graduates are considered important. Thus for measuring the employability, a tool set comprising of all the facets of employability has been considered for evaluating the impact. Number of parameters considered are presented in the figure 1 below.

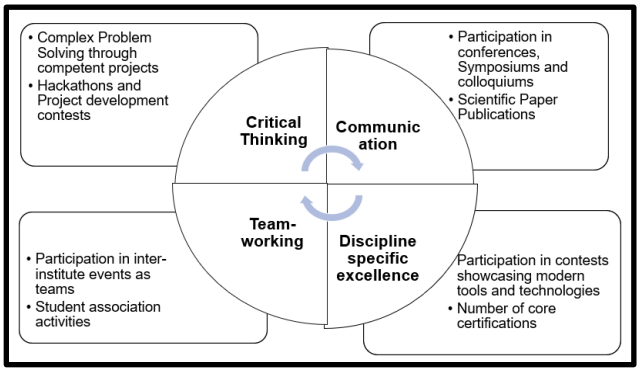

Figure 1. Tools for measuring Employability

To quantitatively measure the impact of the conduct of carefully selected technical courses with suitable industry support on the employability of the passing out students and student projects the following metrics are considered.

- number of students placed in core software companies / Product based companies
- number of publications made by students based on their projects
- number of modern tools and techniques explored by the students

The placement statistics of students of last three passed out batches are presented below in figure 2.

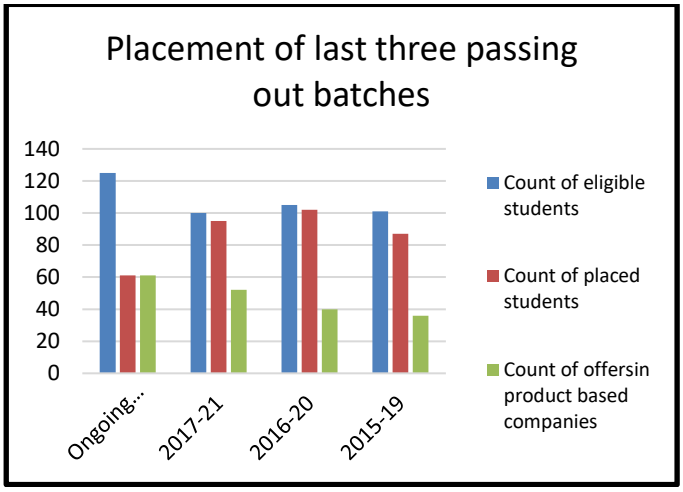

Figure 2. Placement of last three passing out batches

The number of students getting placed every year is consistent over the observed period. However, number of offers from product based companies steadily increases. This reflects a positive impact of industry supported courses. Further, to study the impact analysis of the industry supported courses, core objectives of this category of courses were considered. The industry supported courses offered majorly had one or few of the following core objectives:

- Introducing cutting edge technologies extensively at use in the industries
- Enhancing Application Development skills of students
- Providing hands on exercises on modern tools and techniques
- Promote Teamworking and communication skills by suitable exercises.

The industry supported courses offered for the last three passing out batches are mapped with these objectives based on their contents design and delivery in the table 2. below

Table 2. Mapping of Industry Supported courses with core objectives

Name of Industry supported course	**Technology**	**Application Development**	**Modern Tools and Techniques**	**Teamwork and Communication**
BIG data platform and technologies	✓		✓	✓
Enterprise mobility	✓		✓	✓
Techniques and tools in data science	✓		✓	✓
Hadoop eco system tools	✓		✓	✓
Multimedia retrieval Techniques	✓		✓	✓
Augmented reality	✓	✓	✓	✓
Time series forecasting	✓		✓	✓
Applied predictive Modelling using python	✓		✓	✓
Programming for Internet of things	✓	✓		✓
Mobile app UI test Automation	✓	✓	✓	✓
Watson analytics	✓		✓	✓
Big Data Analytics with Spark	✓	✓	✓	✓
Enterprise application development using Spring	✓	✓	✓	✓
Cloud application Development tools	✓		✓	✓
Virtualization tools and techniques	✓		✓	✓
Practical approaches to networking	✓		✓	✓
SPM using MSF AND AGILE SCRUM Methodology	✓	✓		✓
Malware Analysis	✓		✓	✓
Secure Network Management	✓		✓	✓
Regression Techniques for Engineering Applications	✓		✓	✓
Offensive	✓		✓	✓

Security				
Secure Network Edge and Mobility solutions	✓		✓	✓

To identify the impact created by these courses, notable outcomes such as quality publications, projects and podium finishes in major contests such as nation-wide hackathons, inter-institute and international events are considered. They are listed in the tables 3,4 and 5 respectively below.

Table 3. Notable Outcomes - Projects

S. No	Notable Outcomes – Projects	Academic Year
[1]	Multimodal Biometrics for user Authentication -	2016-17
[2]	Attention Disengagement Analysis For Autism Child	2017-18
[3]	An Ontology Based Text Mining Approach For Document Classification	2018-19
[4]	Augmented Reality Application To Train Autism Kids	2018-19
[5]	Face Expression Recognition For Autism Child	2018-19
[6]	E-Farmer: A Mobile Application for Plant Weed Classification	2019-20
[7]	Evaluation of Fetal Distress Diagnosis during Delivery Stages based on Linear & Nonlinear Features of Fetal Heart Rate	2019-20
[8]	Advisory for Identification and Management of Pest in Agricultural Crops	2019-20
[9]	Intelligent Virtual Tour of the Natural Environment for Autism Children	2019-20
[10]	Indian Signboard Translation using Deep Learning	2018-19
[11]	Energy audit forecasting, Implementing ARIMA model to energy consumption dataset	2018-19

Table 4. Notable Outcomes – Publications

S. No	Notable Outcomes – Publications
[1]	Analysis of the Risk factors of Heart disease using Step-wise Regression with Statistical evaluation, Springer Lecture Notes on Data Engineering and Communications Technologies,2019
[2]	Cognitive Rehabilitation for Autism Children Mental Status Observation Using Virtual Reality Based Interactive Environment, Intelligent Human Systems Integration, AISC, Springer Nature pp. 1213–1218, 2020.
[3]	Analysis and Prediction of the vegetable price using the data mining clustering and classification techniques, International conference on Business Analytics and Intelligence (ICBAI), IISc, Bangalore, 2018
[4]	Feature Extraction and Prediction of Lung cancer in CT Images with enhancement in Image Quality factors using combination of Deep CNN with Extreme Learning Machine, International conference on Business analytics and Intelligence, Indian Institute of Management, Bangalore, 2019.
[5]	Analysis of the Risk factors of Heart Disease using step wise Regression with statistical Evaluation- Emerging Trends in computing and expert technology Chennai,2019
[6]	Sentiment Analysis of Movie Reviews using Support Vector Machine Classifier with Linear Kernel Function, Frontiers of Intelligent Computing: Theory and Applications (FICTA 2020)National Institute of Technology, Karnataka, Surathkal 2020.
[7]	Containers based lab as a service application, International conference on IoT and Its Application, NIT Jamshedpur 2020

Table 5. Notable Outcomes – Win in Nationwide/International Contests

S. No	Notable Outcomes – Wins in the Nationwide/International contests
[1]	Winner- "Nationwide Smart India Hackathon – 2017 – A project on Multifactor authentication
[2]	"Androdate" conducted by Google device lab in NAASCOM,2017
[3]	Winner of Student Innovator Award in State Level Program Conducted by RSAP 2017(Regional Start-up activation Program) powered by Forge accelerator
[4]	Winner of "Datathon" as a part of Kurukshetra, 2018 event organised by Anna University, Chennai.
[5]	Runner up in HCL Hackathon 2018.
[6]	Winner, MithrAI Hackathon
[7]	Winner, TCE Hackathon 2018 on the theme Digital TCE and Digital Madurai

[8]	Winner, Honeywell Automation Challenge 2019 – a 36 hours hackathon
[9]	Winner, ResFest 2019 IoT Challenge, FPT University, Vietnam.
[10]	Runner-up in Smart India Hackathon 2019, Delhi
[11]	Winner, Appathon 2020, A Mobile App development contest to develop an app for Madurai MP
[12]	Winner, Appathon 2020, A Web App development contest to develop an app for Madurai MP Mr. Su. Venkatesan
[13]	Runner-up, TCE – HBTU36 Hrs Hackathon (2020).
[14]	Outstanding performance in Women Innovathon 2020

The exact mapping of these outcomes and the industry supported courses are provided in table 5 below

Academic Year	**Name of Industry supported course**	**Publications**	**Projects**	**Inter-national/ National Contests**
2016-17	Enterprise Mobility			[3]
	Hadoop Eco System Tools			[2] [4]
	Malware Analysis			
	SPM using MSF and agile scrum Methodology			
	Secure Network Management		[1]	[1]
2017-18	Techniques and Tools in Data Science	[3]	[3] [10] [11]	[4]
	Mobile Application UI Test Automation			
	Augmented Reality	[2]	[2] [4] [5] [9]	[6]
	Hadoop Eco System Tools			
	Secure Network Management			
2018-19	Watson Analysis			
	Regression Techniques for Engineering Applications	[1] [5]	[7]	[10]
	Augmented Reality			
	Applied Predictive Modelling using Python	[4] [6]	[6] [8]	
	Enterprise Application Development using SPRING			
	Offensive Security			
2019-20	Virtualization Tools and Techniques			
	Mobile Application UI Test Automation			[11] [12]
	Secure Network Edge and Mobility Solutions			
	Watson Analytics			[13]
	Building Scalable Applications with Micro Services	[7]		

The impact analysis presented above directly measure the impact of industry supported courses on the learning outcomes of the students. In addition to this, improvement in faculty competency is also considered as an important impact of collaborating with industries for offering courses. The internal faculty would extensively collaborate with the industry expert for framing the syllabus, preparing the courseware, content delivery and assessment of the course. This would facilitate an ongoing collaboration between the industry and the internal faculty, effects of which may be observed in the collaborative research work and exposure to contemporary tools and techniques. This, in turn would have a positive impact on the quality of the content

delivery and assessment carried out by the internal faculty. Number of industry relevant courses are added to the curriculum out of such fruitful collaborations. Also, the contents of the existing courses are enriched out of such collaborations. Two such courses in which the existing contents are revamped with industry relevant contents are presented as examples below.

Case 1: Software Engineering:

Software Engineering is a course offered to III semester students to lay a strong foundation for building quality software in a productive manner. In 2018, the course outcomes and course contents were revisited in collaboration with Industrial experts from Honeywell Technologies. Now, the course emphasises on Agile Methodologies and Devops Practices in order to expose the students industrial software development. Students develop applications using scrum framework such as writing user stories, sprint, having sprint meeting etc. The revamped syllabus may be viewed at https://tinyurl.com/8n5yxu5j

Case 2:Web Technologies:

This course covers the design, implementation, and testing of web-based applications. The students will learn about mark-up languages, scripting languages, interactive graphics and databases. The course contents were revamped to include contemporary technologies such as nodejs, angular framework and NoSQL databases upon getting feedback from industrial experts. The course's syllabus with the revamped contents is available at https://tinyurl.com/3u3xtnp6

Along the lines of enriching curriculum through industry collaborations, some courses are introduced to expose the students to recent developments ,practices and trends in the areas of data, security, distributed computing. Some of the examples are given below.

Case 1. Service Oriented Computing:

This course provides students an understanding on architectural styles such as SoA, RESTful and Microservices that are used to develop software applications as services that are autonomous and platform independent. Also, insights into the tools such as Docker containers and Kubernetes for deploying and managing the microservices are provided. The course has been designed as a follow up of the industry supported course on Containerization Technologies in association with VMware. The full syllabus of the course is available at https://tinyurl.com/3mjhjak2

Case 2.Blockchain Technologies:

This course provides knowledge to students to build their own application with blockchain and crypto currency concepts. This course has been developed following up the inputs from IBM and Symantec during various industry supported course-run. The full syllabus may be viewed at https://tinyurl.com/3kf8cy39

Case 3.Programming for Internet of Things:

This course aims at providing basic knowledge and skills to engage in innovative design and development of IoT solutions. The course contents are up-to-date with the industrial trends as a result of fruitful collaboration with Honeywell Technologies. The full syllabus is available at https://tinyurl.com/nch8zvp8

Course End Survey

The feedback of the students on curriculum design, content delivery and assessment are collected specific to every industry supported course to enhance the learning environment. The feedback of the students on a rating scale of 1 to 3 on various parameters for the course on 18CS1C0 Containerization Technologies is highlighted in the

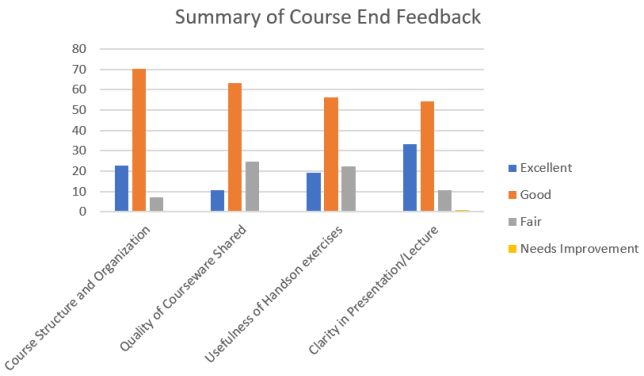

Figure 3. Course End Feedback Summary

It could be inferred from the feedback that the majority of the students were satisfied with the content delivery and assessment of the industry supported courses. In case the feedback is not up to the expected level, necessary corrective actions are taken during the next course offering.

Student Satisfaction

The satisfaction of the graduates with the industry institute collaboration has been analysed in the annual student satisfaction surveys and is depicted in figure 4 below.

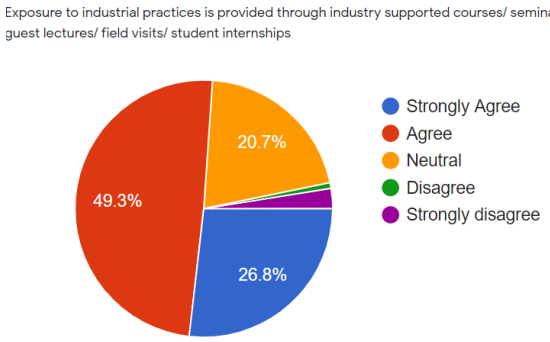

Figure 4. Students Satisfaction on Industry Institute Collaboration

It could be inferred from the figure that more than 75% of the students have given top two ratings.

6. Conclusion

The collaboration between industry and institute serves as a catalyst to promote innovation in research and development in the latest trends. Industries often focus on addressing solutions that are of commercial value. The major focus of academia is to build new knowledge through research and education to the students community. The combination can yield accelerated development of innovations in product building. It could be inferred from the data analysis that the industry supported courses have a significant positive impact on the product building skills of the graduates and in employability. The research work shall be extended to analyze the impact of industry participation in curriculum design, project reviews, seminars and internships.

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