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Industry-Academia Collaborative Teaching – A Journey

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Abstract : Industries spend tremendous amount of time and money in converting a fresh graduate to a workable employee due to the gap between academic curriculum and industry needs. There is a growing demand for creating employable man power at university level by suitably augmenting the university curriculum. Organizations like CII, NASSCOM, National Skill Council of India, AICTE are stressing the need of imparting industry needed skills to engineering students in campus. Certain IT and related industries are increasing their focus to creating readily employable man-power rather than involvement in research activities with universities. This paper presents a case study of evolution of collaboration between industry, Govt agencies and the institute to impart industry-oriented training in campus, with an integrated curriculum. The paper provides a methodology for developing and implementing of the collaborative course delivery that can be adopted by different engineering studies. The success of the collaborative teaching has been shown by means of observed benefits using certain performance metrics.

Keywords: Industry oriented course, Curriculum, Skill training, Collaborative training, Man power, Competency based Education.

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1. Introduction

Motivation behind this study is bridging gap between academics and industry. Academicians recommend curriculum that cover fundamental concepts, principles, algorithms, mathematical analysis and reasoning etc. In the typical scenario of engineering curriculum the teaching is distributed over science, mathematics, humanities and management, basic engineering, professional core courses and choice based electives. The syllabus caters to different needs of the society, namely, higher study, research and teaching, civil services, govt. and industry jobs. It is recommended to change curriculum after 5 years, maximum 7 years to keep it up-to date with changes. Five years is considered to be a comfortable period for stabilizing the curriculum and reap its benefit. Under the scenario, institutions struggle to find ways and means of satisfying the dynamic demands from industry and market. This paper presents implementation of industry collaborative engineering teaching used in the last 10 years in the author's institution in India. The evolution of the collaborative framework to bridge the gap between industry demand and university education finally culminating in an integrated curriculum has been discussed. Additionally a set of performance measures have been suggested to quantitatively evaluate the impact and benefits.

2. Literature Survey

Academicians often lose focus on the changing needs for corporate jobs, self employed and entrepreneurs due to leanings for research. AICTE and CII carried out survey in 2012 and 2017 on institutions involved in industry collaborations which are available on their web sites (vide AICTE-CII Survey report, 2012 and AICTE–CII SURVEY OF INDUSTRY Linked Technical Institutes, 2017). In the 2017 survey the institutions were asked to provide data about their industry linkage to which 9524 institutions responded. A total 783 institutions then participated in a full survey and submitted detailed questionnaire response. Only 4 institutes scored 60% and 22 scored 50%. Accordingly institutes were classified as platinum, gold if the score was above 30%, or 10%, and the rest were categorized as silver.

The need for collaborative teaching at different levels with industry partners has been proposed by several authors. Several authors have studied innovative method used by universities in developing countries (Brundenius. C. et al, 2009). Innovative policy platform consisting of University and Industry collaboration in developing countries has also been reported in pedagogy literature (José Guimón, World Bank , 2013). Interactions between Industry and Academia have been considered as a key factor to adept to technology innovations and globalization (Pai et al., 2007).

While collaboration at policy and research level has been there for quite some time specifically in developed countries, authors have suggested industrial project based and internship based learning (Abdulwahed, M et al 2009, Mills, J. E., & Treagust, D. F. 2003, Shaban, K. B., & Abdulwahed, M. 2012, Linn, P. L., Howard, A., & Miller, E. (Eds.). 2004). Several success stories have been reported by authors around the world for collaborative teaching in specific area or specific course. Collaborative way of teaching Software Engineering was elaborated by Weidong Zhao et al, in 2008. Similarly teaching the Data Warehouse course in collaboration with industry has been reported (Estelle Taylo 2012). Success stories of collaboration between Intel and Malaysian Universities were reported (Chandran et al., 2010) for improving electronic packaging teaching and learning. Various success stories of enhancing the teaching learning experience in specific skill area using industry and institution collaboration have been reported by authors (Pai P.S., Chiplunkar N.N, 2015).

Though the need of industry collaborative teaching has been identified as a need for progressive educational institutes the implementations reported seem to be short term measures. Long term approach such as integrating course curriculum at undergraduate level with industry participation is still at very early stage. The contribution of this paper is in evolving an industry integrated curriculum for undergraduate engineering program, making it operational and measuring its benefits.

In section 3 the methodology used for the creation and implementation of the integrated curriculum and collaborative teaching for undergraduate program is explained. Subsequent sections describe the data analysis and results. Finally, the paper is concluded with discussions and future directions.

3. Methodology

Effort was carried out for our home institution, an autonomous Engineering institution in India, for industry collaborative teaching in undergraduate engineering programs. Though this paper focuses on the under graduate programs in Computer Science and Engineering (CSE) and Information Technology (IT), the methodology can be adapted for any branch of engineering program. The method consisted of the four distinct steps:

- Course identification for industry collaboration
- Creating partnership
- Implementation and scheduling of the industry based courses
- Evaluation and improvement.

A. Identification of Course

This activity involves determining the gap between the academic program curriculum and the current need of the industry. New technology adaptations in certain industry sectors like IT, Telecom and IT enabled services is very fast. This has speeded up with many start-up entrepreneurs who try to get advantage of latest technology.

To get the current industry outlook and demand, data can be collected from various sources, such as structured feedback collected from our alumni in various segments of industry, and publications from industry bodies and consultants such as NASCOM, Gartner, PWC, Accenture, Bain etc. was considered. Formal and informal interactions with premier institution experts and their HR or placement representatives was another important source. The suggestion of graduating engineers in the exit feedback was also taken into consideration. All these together provide a kind of 360 degree information regarding the intended industry oriented courses to be introduced as shown in Figure 1.

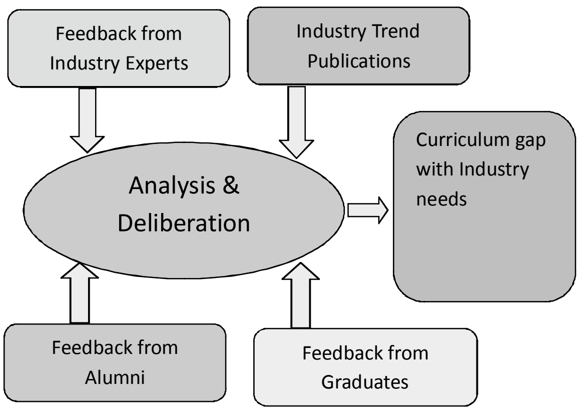

Fig.1: Identification of Industry Courses

B. Creating Partnership

This is an activity of interacting with suitable industry partners to establish an understanding document (MOU) for the partnership. This will include the scope, mode of operation, time period, faculty training, cost and other contractual terms and conditions. To be able to select the right partners one has to study their academic programs and match them with the identified technology courses. The mode of course delivery, mix of external and internal faculty, and internal faculty training are issues which need to be worked out at this phase. Another factor in this direction is that the existing laboratory infrastructure normally will not be able to support such type of technology partnership with industry-academia programs. Necessary budget allocation has to be made for the development of infrastructure and procurement of equipments and software as per the requirement of the specific industry partnership.

C. Implementation and Scheduling

Implementation involves integrating the industry-collaborative course to the curriculum. This can be done in several ways. The easier way is to treat it as an additional skill component in the program. Such courses are like audit courses with no credit component. The demerit of such a method is that it adds burden on the total contact hours for the student. Also, scheduling both credit and audit courses within the academic calendar is difficult. Another approach is to bundle the industry courses and place them in a particular semester. Then a grade equivalence scheme can be worked out for such courses and equivalent credit can be transferred to the regular curriculum. This type of treatment is well suited when the industry course is an optional choice for the student. A more innovative approach is to completely integrate the industry based courses as part of the curriculum with suitably assigned credits. In such an approach one has to balance the basic and professional course requirements of the university with the industry based courses. The placement of the courses within the 8-semester graduate course with proper pre-requisite course also places a challenge. The planning and designing of such type of integrated curriculum often involves several iterations of brain storming of the faculty along with external experts of the Board of studies. Once these issues are resolved and the curriculum is approved the schedule of course delivery program can be finalized with necessary resource assignment and published for proper implementation.

D. Evaluation and Improvement

This step involves data collection and analysis of the impact after implementation of the industry collaborated teaching. The impact or outcome can be measured either qualitatively or quantitatively on different parameters. These evaluation results provide an insight to the success of the implementation and can be used for further improvement.

In this case study, different implementations carried out for the undergraduate Computer Science and Information technology undergraduate programs have been presented as it changed and gradually evolved over years for improvement. The success of collaborative teaching was measured using student attendance, student feedback and satisfaction, teacher feedback, placement results, and company internship.

4. Data Analysis And Results

Data from the Alumni feedback survey and Graduate exit survey were collected and analysed as part of activity (A). The number of alumni selected for the survey was around 30% of the graduating student strength in a branch. To be able to get usable information, alumnus who had already served for 3-4 years in industry was selected using online application. The relevant part of the survey questionnaire used for the analysis is illustrated in Figure 2. The graduate survey was conducted using Google form wherein over 95% of the outgoing students participate each year. The relevant portion of the graduate survey format which was used for the data analysis of the current work is shown in Figure 3. Based on this information the study areas or courses for industry collaborative teaching were identified. Published work on industry trends, and interaction with area experts from premier institutes was used for validation and fine tuning of the results obtained from the feedback analysis.

Appropriate partnerships were established after due deliberation with multiple parties. The evolution of collaborative effort for the CSE and IT undergraduate programs over the last 10 years is summarized in Table 1. For the batches graduating from the year 2008 to 2017 such courses were imparted as additional skill augmenting the curriculum. The partnership was with separate vendors for each skill type. Also, few skills were imparted in workshop mode. These additional courses could not be made credit courses within the curriculum due to the fact that the program curriculum was prescribed by the University and could not be modified by the institute.

Though the acceptance and satisfaction of students was good, it created pressure on the students due to enhanced contact hours. For the batches that were admitted in 2015 and graduating in 2019, such courses are made part of the program curriculum, as the institute moved from affiliated college to an autonomous institute and university structure.

Comments/Suggestions:

- *Please feel free to comment on the program and its graduates in terms of their professional qualities and on any specific areas of strengths and weaknesses.*
- *Please feel free to suggest any improvements to our programmes of study to make it better fit to current industry environment.*
- *Thank you for your input and please let us know about any comments or suggestions that you may have in the future to help us improve the quality of our programme and the graduates.*

Fig. 2: Relevant Portion of Alumni Survey Questionnaire

Comments/Suggestions:

- *Please feel free to comment on the programme and its graduates in terms of their professional qualities and on any specific areas of strengths and weaknesses. Also, please feel free to suggest any improvements to our programmes of study.*

1. List the courses within your Program from which you benefitted the most.

2. Which courses provided the best practical experience?

3. What is your suggestion for improvement of the program in terms of new courses and teaching / learning methods?

Fig. 3: Relevant Portion of Graduate Survey Questionnaire

Table 1. Graduate & Alumni Survey Summary And Industry Collaboration

Graduating year	**Alumni:** Part of the graduate study helped most in industry	**Industry Sources:** Courses required for industry employability	Collaboration in the graduating period
2008 & 2009	Programming courses on C, C++ and Web technology	Web design tools and Object Oriented programming in the syllabus	Local corporate trainers
2010 & 2011	Dot Net technology	Programming with modern software	Microsoft partner
2012 & 2013	Java programming, Training on Linux administration, IIT Mumbai's Spoken Tutorial course on PHP, MySQL	Use development tools in laboratory work	Linux partners, IIT Mumbai
2014 & 2015	Java and IBM-Rational tools, Workshops on Testing and Open sourc e tools, Workshops on Cloud Computing, Data Mining	Use of open source software and tools in the syllabus	IBM partner, IIT KGP and NIT Rourkela for open source software

2016 & 2017	Java and Oracle certification courses, CISCO certification courses, Workshops on Cloud Computing	Open Source, Enterprise programming, Cloud computing, Big data analytics	Oracle partner, CISCO partner, IIT KGP and NIT Rourkela for open source software
2018	CISCO certification courses, Open Source, Machine Learning, IoT certification course	Cloud Computing, IoT with Rasbery Pi, Big data and Hadoop stack, Mobile computing Android programming	CISCO partner, CDAC partnership

The motivations to go for industry academia integrated curriculum were:

- The institution was moving from affiliating university syllabus to own syllabus and academic regulation under the autonomous status in the year 2014-15.
- Changes in the Information and Communication Technology environment was significant introducing new paradigm such as Infrastructure management and Cloud services, Sensors and Internet of things (IoT), Big data, Machine learning, Deep Learning, IT Security.
- These areas needed in depth theory and specialized software and tools which cannot be satisfied by few extra skill-based training.
- Existing teachers did not have teaching experience for such courses.
- CDAC was giving job-oriented diploma courses at Pune, India. These courses had a high level of lab practice.
- CDAC conducts campus drives at Pune and IT product, services and IT related industries all over India participated in the hiring process.

After due deliberations, partnership with CDAC was established for undergraduate CSE and IT courses. A new curriculum was designed by integrating the CDAC PG diploma courses as part of B.Tech CSE and IT syllabus sith adequate credits and implemented from the 2015-19 engineering batch. The impacts of these innovative measures are presented below.

A. Attendance:

While the average student attendance in regular courses varies between 60% and 80%, attendances in skill courses measured 80% to 100%. The same was

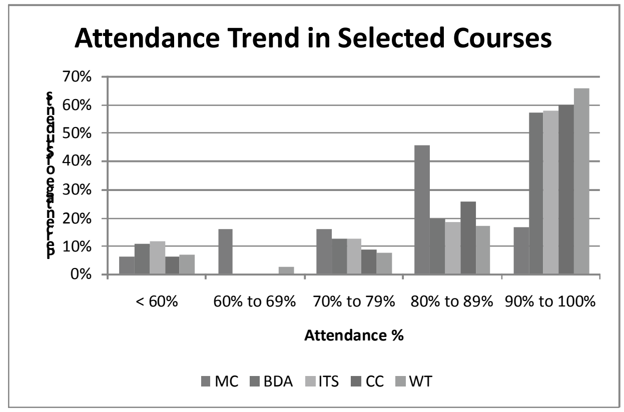

Fig. 4: Attendance trend for CDAC courses selected from 1st, 2nd and 3rd year B.Tech CSE and CS&IT

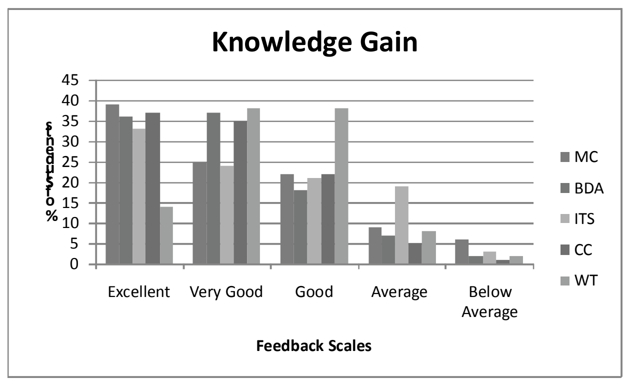

Fig. 5: Course Satisfaction for Correlating Concepts with examples and Knowledge Gain

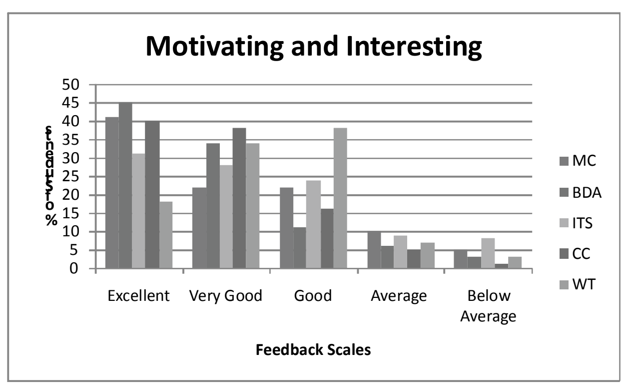

Fig. 6: Course Satisfaction for Interestingness and Motivation

Course Feedback

1. *What was the coverage of course contents*
2. *Degree of adequacy of materials received*
3. *Capability of instructor to explain concepts with examples and the knowledge gain by students*
4. *Whether the course is interesting and motivating*
5. *Punctuality and regularity of course conduction*
6. *Time management for course content coverage (speed of delivery)*
7. *Student Interaction*
8. *Instructors attitude towards students*
9. *Whether the assignments and tests were timely evaluated and discussed*
10. *Strength and weakness of the course or trainer (in words)*

Fig. 7: Course Feedback Parameters

true for courses taught by CDAC's practicing trainers from industry. Figure 4 illustrates this trend for 5 subjects, namely, Web Technology (WT), IT Infrastructure and Cloud Computing (CC), Big Data Analytics and Hadoop Stack (BDA), IT Security (ITS), Mobile Communication and Android Programming (MC).

B. Student Feedback and Satisfaction:

Students' satisfaction for each course taught by industry collaboration was measured by taking feedback during and at the end of the course using several parameters in 5 point scales. This is illustrated for 2 selected parameters in Figures 5 and 6 out of 10 parameters in the feedback form (vide Figure 7). While Figure 5 shows the course satisfaction for correlating concepts with examples and incremental knowledge gain, Figure 6 depicts the level of interest of the students and their motivation for the course. In general the average student satisfaction index for industry oriented collaborative courses was found to be “very good”. The student's appreciation was high as the laboratory component was higher and they could relate the theoretical knowledge to real life problems and applications.

C. Faculty Feedback:

This parameter was measured qualitatively in departmental course coordination meetings. Teaching the core and professional courses was found to be easier by institution's faculty members as the grasping level of student increased due to hands-on component in industry collaborative courses. This also resulted in general decrease of failure rates.

D. Placement:

It is difficult to measure the impact on the placement numbers, as there are other contributory factors such as market scenario and manpower demand. Also, IT corporate houses recruiting fresh graduates in large numbers look for proficiency in basic skills, instead of specialized skills. However, the following positive impacts were observed:

1. The number of companies coming for campus increased over years from 10-12 to 25-30.
2. The highest pay package increased from 2 Lakhs in 2008 to 9 Lakhs in 2017. Subsequently the number of students getting 5 Lakhs to 9 Lakhs has increased.
3. Students were offered paid internship by several industries in the last semester of engineering study. The number of industries taking interns has increased from 1-2 to 15 over this period.
4. The scores in certification and employability tests like AMCAT and Co-Cube has increased and students received jobs directly in other companies through AMCAT / Co-Cube within 3 months of passing, increasing their choice of jobs.
5. Students, having successfully completed courses offered by CDAC were certified and eligible to get jobs from placement drive of CDAC.
6. CDAC being an industry neutral govt. agency this increased employability opportunities.

E. Company Internships:

Until 2016 students who received internship offers from recruiters did not want to accept the offer. This led to the introduction of grade equivalence for industry internship in final semester as part of autonomous regulations. Accordingly, from 2017 onwards the number of students accepting the internship offer has seen an increasing trend. The number of industries taking interns has increased from 1-2 to 15 over this period. There is also a growing interest from product companies taking final semester students as interns which automatically gets converted to job offer at a higher salary range.

In 2018-19 the students accepting internship was at 30% of the batch strength which is expected to increase further with increase in number of companies offering internship. In spite of these success factors there are challenges to be resolved, such as non-performing students, accommodating to academic calendar, and managing resources.

5. Discussions

The journey of providing industry collaborative courses in CSE and IT under graduate engineering programs in the institution established in 1997 began around 2007- 2008 as an effort to bridge the gap between industry requirements and the academics followed in universities. The paper has suggested a generalized methodology or a framework followed to adapt to the type of skill training required as per the technological advancement over years. Also, a set of metrics has been used to evaluate the impact and benefits of these approaches, including the satisfaction index and industry placements suggested by few researchers in their success stories (Chandran DPK et al 2010, Estelle Taylo 2012).

The journey which started with imparting specific industry-oriented skill training has finally evolved to the current scenario of industry integrated curriculum which is supplemented with small component of skill courses that act like bridge courses. Additionally, the final semester company internship provision has been introduced as on optional choice providing a hybrid approach for industry-oriented teaching and learning linked with placement.

The impact and benefits of the combined curriculum and collaborative teaching approach have been measured and the results have shown an improved impact in terms of acceptance and satisfaction. Other benefits in terms of job opportunities have shown significance improvement.

6. Conclusion

This paper has presented an industry integrated curriculum as a framework of collaborative engineering education for bridging the gap with industry requirement. The success of these programs in the Computer Science and Information Technology related programs of the institute has been found successful and these approaches are being replicated for other engineering branches with suitable modifications with branch specific industry partners.

It may be noted that the steps mentioned in the methodology section of identifying gap with future industry trends and incorporating industry collaboration needs to happen in a cyclic way, and hence it is a continuous journey.

Mahmoud Abdulwahed (2019) in chapter 12 of the book: "Industry Integrated Engineering and Computing Education - Advances, Cases, Frameworks, and Toolkits for Implementation", has suggested that competency based (or outcome based) education is very suitable for complete integration of industry in engineering education imparting combination of knowledge, value or behaviour, and skills or capabilities. Though an attempt has been made in the current work to study different approaches for industry collaboration including the joint curriculum and hybrid approach with internship, new innovative teaching methods need to be worked out to improve the success of the collaborative programs, making it both value and skill based.

Another dimension which can be researched is the impact of student-centric or learner-centric education which takes care of learning pace. Designing a curriculum and evaluation method which is learner-centric as well as industry based would probably be the future challenge to the engineering community.

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