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Designing and Delivering Curriculum with Early Industry Exposure Integration: A Model

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Abstract

The university industry's cooperation in curriculum development and delivery has been identified as a key support factor for universities. Hence, universities are looking for an association with the industries that will help them to enhance their translation research and build skill sets, enabling them to work on real-life challenges. Conversely, to remain competitive, industries look for academic collaborations in their research and development activities. To provide students and researchers with good exposure to the industrial environment, courses offering internships in the industry field have proven to be beneficial, and many curriculum development models associated with the industry connect are available in the literature. This paper describes an industry internship program designed for third-year undergraduate engineering students focusing on the Internet of Things (IoT) course. The main objective of this work is to offer students the opportunity to gain familiarity with the industry environment and practical experience, mainly through collaborative teamwork. The study is implemented using a problem-based learning pedagogical approach. The program consists of three primary stages: preparatory training for the internship, the internship duration itself, and the internship projects. The model was successful for the IoT course delivered and assessed in collaboration with the industry personnel. The key outcomes of this industry internship are teamwork, industry readiness, effective communication, and presentation skills.

Keywords**—**IoT; Industry Internship; Teamwork; Thinkspeak; University- Industry collaborations; PBL

I. INTRODUCTION

The collaborations between industries and academic institutes are indeed crucial for various reasons. The advantages include work-ready talent development, specialized education, access to state-of-art technologies, mentorship, guidance, research opportunities, networking, and recruitment. The industry-institute collaborations allow students to gain practical, hands-on experience and exposure to real-world industry challenges. This exposure helps students become employable by developing skills directly relevant to their chosen professions. They can apply theoretical knowledge in practical settings, making them more attractive to potential employers. Through collaboration, academic institutions can tailor their programs to meet the specific needs of industries. This leads to the developing specialized courses and training programs that align with industry demands. As a result, students graduate with expertise in their chosen fields, making them more valuable assets to employers [1].

Collaborating with industries provides universities with access to cutting-edge technologies and equipment. This access allows students and researchers to work on projects that use state-of-the-art tools, enhancing the quality and relevance of their work. The industry experts can mentor and guide students and faculty members. This mentorship helps to bridge the gap between academia and industry by providing insights into current industry trends, best practices, and real-world problem-solving approaches. Such guidance can significantly enhance the quality of research and education at academic institutions [1].

Collaboration often leads to joint research projects between academic institutions and industries. This synergy fosters innovation and encourages the development of new technologies and solutions. Moreover, it allows students with the opportunity to engage in meaningful research that addresses practical problems, contributing to both their academic growth and the advancement of industries. Collaborations facilitate networking opportunities for students and faculty members. They can attend industry events, seminars, and conferences, allowing them to connect with potential employers and gain a deeper understanding of industry dynamics.

Additionally, industries often recruit talent directly from these academic partnerships, benefiting both parties. The industry-institute collaborations can stimulate economic growth at regional and national levels. By producing highly skilled graduates and fostering innovation, these collaborations can attract more businesses to the area and create job opportunities, ultimately contributing to economic development [1].

The paper is organized as follows: section II deals with the relevance of IOT. The methodology is presented in section III. Section IV focuses on experimental outcomes and discussion. Finally, the conclusion is summarized in section V.

II. RELEVANCE OF IOT

Indeed, the rapid expansion of the Internet of Things (IoT) is transforming how we interact with technology and the world around us. A recent survey predicts that people will interact with linked gadgets 4,800 times. By 2025, it is anticipated that

80 billion gadgets will be linked to the internet. Consequently, there is a high demand for technologies enabling data collecting and networking [2]. The Internet of Things allows for this. Here are some key points to consider regarding the importance of incorporating IoT courses into the curriculum:

Industry Relevance: As IoT technology becomes increasingly integrated into various sectors such as healthcare, manufacturing, agriculture, and smart cities. There is a growing demand for professionals who can design, implement, and manage IoT systems. Offering IoT courses ensures that students are equipped with skills directly relevant to the job market [4][5].

Skill development: IoT courses can provide students with practical knowledge and hands-on experience in sensor technology, data analytics, cloud computing, and network security. These skills are essential for developing IoT solutions and addressing real-world challenges.

Interdisciplinary learning: IoT is inherently interdisciplinary, involving aspects of computer science, engineering, data science, and even ethics and privacy considerations. Integrating IoT courses into the curriculum encourages cross-disciplinary learning and collaboration among students from various backgrounds.

Innovation and Entrepreneurship: IoT presents numerous opportunities for innovation and entrepreneurship. By offering IoT courses, educational institutions can foster a culture of innovation and encourage students to develop their IoT-based projects and startups.

Industry Partnerships: Collaborating with industry partners can enhance the quality of IoT courses by providing access to real-world projects, guest lectures from industry experts, and internship opportunities for students. These partnerships can also help in shaping the curriculum to meet industry needs.

Competitive advantage: Students who graduate with IoT expertise will likely have a competitive advantage in the job market. Many companies are actively seeking IoT specialists to drive digital transformation initiatives and harness the power of connected devices.

Societal Impact: IoT has the potential to address pressing societal challenges, such as improving healthcare, conserving resources, and enhancing the quality of life. Teaching students about IoT's societal impact can inspire them to work on projects contributing to positive social change.

The inclusion of IoT courses in the curriculum is not only relevant but also essential to prepare students for the evolving technological landscape. It equips them with the skills and knowledge needed to thrive in a world increasingly driven by interconnected devices and data. Additionally, it aligns education with the demands of the job market, fostering innovation and providing students with a competitive edge in their careers [6][7].

III. Methodology

The experiments aim to enhance the technical and interpersonal skills of undergraduate students through early involvement of the industry in the learning phase. The course is structured to leverage the strengths of Problem-Based Learning (PBL), Blended Learning, and continuous Assessment and Feedback [8-10]. This methodology ensures that students acquire theoretical knowledge and apply it to solve real-world IoT problems, receive consistent support and feedback, and utilize both online and in-person resources effectively.

The objectives of an internship in a curriculum for students include:

a. Providing real-world work experience.
b. Fostering practical application of classroom knowledge.
c. Developing professional skills and networks.
d. Exploring career interests and opportunities.
e. Enhancing employability and readiness for the workforce.

The internship is designed with a focus on IoT (Internet of Things), which provides valuable hands-on experience in developing and implementing IoT solutions.

Participants learn about the interconnectedness of devices and systems through practical projects and assignments. The IoT course covers various aspects of IoT, including sensors, data collection, cloud computing, and security protocols. Interns gain insight into the real-world applications of IoT across industries such as healthcare, manufacturing, and smart cities.

The objectives of the course are:

a. Introduction to IoT Architecture
b. Overview of Node MCU and its programming
c. Knowledge of various sensors and their usage in IoT systems
d. Communication Interfaces- UART, I2C, One-wire, and SPI
e. Developing an IoT solution

Table I depicts the stages and approach to implement the internship program. The internship was carried out in three phases: preparation, internship period, and the internship project.

Preparation for the internship: The preparation period for the project was essential for ensuring its success. During the preparation phase for the internship, it is crucial to manage both the amount of time allocated for the internship and the scope of the project to be undertaken during this valuable learning opportunity. During this stage, students will receive guidance on establishing the necessary environment on their systems and completing the necessary account registrations on IoT cloud platforms. This process will be completed before the classroom session, ensuring that participants' systems are adequately equipped with the necessary hardware, software, and configurations for the projects. The pre-internship assessments assessed the students, which will help in preparation and for the facilitator to assess the knowledge level.

TABLE I
IMPLEMENTATION PLAN

Phase	Duration	Description
Preparation	**Week 1-2**	**Course Introduction and Problem Presentation** • Introduction to IoT and course structure. • Presentation of the main problem and initial brainstorming.
	Week 3-6	**Research and Exploration** • Online and offline lectures on IoT concepts and technologies. • Students research and discuss possible solutions.
Period	**Week 7-10**	**Solution Development** • Hands-on workshops and lab sessions. • Development of IoT prototypes and initial testing. • Reviews and formative assessments.
Project	**Week 11-14**	**Implementation and Testing** • Continued project development and troubleshooting. • Reviews and formative assessments.
	Week 15-16	**Finalization and Presentation** • Final project implementation and testing. • Project presentations and summative assessments.

Internship period: The internship period is approximately 30 to 40 hours. During this period, students delve into the core aspects of IoT. They are expected to gain practical skills related to IoT system prototyping, including activities like sensor integration, data communication, and working with IoT hardware and software components. This training likely includes an introduction to key IoT concepts, programming in Python, and possibly other relevant skills. The participants are instructed on setting up the necessary environment and accounts on IoT cloud platforms. This preparation ensures students have the tools and resources needed for their internship activities.

The aspects addressed in this phase are:

- **Device-level programming:** The students will get to understand NodeMCU, a prototyping platform for IoT. This will include basic electrical components, NodeMCU hardware and software, and sensors.

- **Communication protocols**: The students will get an overview of network interfaces and communication protocols. NodeMCUWi-Fi and TCP/IP programming using networking API have been covered in detail.

- **IoT cloud platforms**: The students will get an overview of IoT cloud platforms and their roles in IoT systems. The ThingSpeak as a cloud platform is covered in detail. The students have understood Thing Speak APIs and how to push the data from Node MCU to ThingSpeak.

Internship Project: This phase involved the assignment of the project to the team by the facilitator from the industry. The scope and expected deliverables of the project are also detailed. Each team is assigned a mentor who provides guidance, support, and feedback throughout the project. The mentor clarified expectations and provided resources to ensure the intern team stayed on track and met the project goals.

The sample problem statements are:

1. Design and implement an Internet of Things (IoT) system that monitors ambient temperature and humidity using a DHT11 sensor, processes the data, and sends it to a cloud platform and/or serial terminal. The system should provide real-time alerts through LEDs and post updates to a Twitter account.

2. Design and implement a smart street light control system using LEDs, a PIR sensor, and a light sensor. The system should automatically manage street lighting based on ambient light conditions and the presence of people, and it should log operational data to an IoT platform and post updates on Twitter.

The unique features of this course are as follows:

- Integrated course design that gives equal weightage to both theory as well as hands-on experience
- Design of course content based on industry inputs
- Academia and industry both contribute equally to the delivery of the course
- At multiple levels, co-assessment is done by both academia and industry
- Successful completion of the internship leads to rewards from the industry

At the end of the course, the student should be able to

- Illustrate the programming with NodeMCU
- Acquisition of data from various kinds of sensors
- Interfacing with serial port, I2C, and
- Uploading data to the cloud -Sensing with NodeMCU and sending to ThingSpeak using Wi-Fi.

A. *Course assessment*

Tables II and III depicts the evaluation rubrics and assessment criteria that are carried out in this internship. The continuous assessment consists of four reviews during the semester. Reviews 1 and 4 are assessed for ten marks, whereas reviews

2 and 3 are assessed for 15 marks each. The end-semester assessment is assessed for 50 marks. There are 14 teams, and each team is comprised of 4 interns. The performance indicators are mapped to the rubrics. All four reviews are assessed by both the academic experts as well as the industry experts. During each review, valuable input was given to the teams to achieve their project objectives. Thus, outcomes are achieved through continuous assessment/reviews.

IV. Experimental outcomes and discussion

The assessment of this course's effectiveness entails the consideration of various measurement parameters. Following the principles of outcome-based education (OBE), all course outcomes and associated questions are aligned with the competency program outcomes (PO) outlined in the ABET criteria. The results revealed areas for potential improvement and highlighted the significant benefit to learners who demonstrated the ability to solve practical problems using the acquired concepts. This activity served as a learning platform for both facilitators and students alike. The experimental and student feedback are tabulated in Tables IV and V, respectively.

Dedicated feedback is surveyed from the sixty-five students to solicit input on various aspects of the internship, including program structure, learning opportunities, mentorship quality, and overall satisfaction. Consequently, over 90% of students have noted that the course significantly enhanced their comprehension of IoT fundamentals, data collection from diverse sensors, NodeMCU programming, and transmitting data to Thinkspeak. As a result, the course has effectively prepared students with essential skills, marking a significant outcome. Throughout the course, students have demonstrated high levels of interest and enthusiasm for learning.

The pre-internship survey was carried out to gauge the students' perspectives and expectations about the internship. Table IV shows the mean of all the questionnaires and the corresponding mean. The mean response of 8.28 for the first question indicates high excitement among respondents about starting their internship. A mean response of 3.9 to the question "How prepared do you feel for the challenges you might face during your internship?" suggests that, on average, the respondents feel somewhat underprepared for the challenges they anticipate encountering during their internship. Therefore, the preparation phase was modeled to provide additional support, resources, or training to address these concerns and enhance interns' confidence and readiness for their internship experiences. The third and fourth questions revealed that the students had positive expectations of the internship program they would undergo. The fifth question was a survey after the preparation phase of the internship program. The mean response of 8.14 to the fifth question indicates a high level of satisfaction among respondents regarding the support and guidance they received in preparation for their internship.

TABLE II
EVALUATION CRITERIA

Sl. No.	Assessment Criteria	Weightage
1	Continuous assessment	50%
2	End-semester assessment	50%

TABLE III
SUMMARY OF RUBRICS FOR EVALUATION

Parameters	PI	Marks
Review-1: Initiation		
Conversions of given need statement into problem statement (engineering requirements)	2.2.1	5
Read, understand and interpret technical and non-technical information	10.1.1	3
Identify the gaps in research through literature survey	12.1.2	5
Identifying multiple solutions and selecting the best suited solution and justifications with support of technical literature	2.2.4	5
Understanding of professional ethics Copy right, plagiarism	8.2.1	2
Review-II: Planning		
Project Planning (Gantt chart) and WBS (Work Breakdown Structure)	11.3.2	5
Specification and identification of input & output.	2.1.2	5
Functional block diagram relating. input & output, Design specifications and Bill of Materials (BOM)	2.2.4	5
Simulation and Implementation	5.2.2	5
Present results as a team	9.3.1	5
Draft copy of first chapter of the report, “Introduction”, with literature survey.	10.1.2	5
Review-III: Execution		
Detailed block diagram with all specifications /algorithms.	13.2.1 13.3.1	10
Integrating the functional blocks, debugging details and Partial demonstration of results.	3.4.1	10
Plan and need for optimization	3.2.2	5
Draft a copy of project report	10.3.1	5
Review-IV: Closure		
Implementation, demonstration and analysis of results.(Pre & post optimization discussion)	13.2.2 13.3.2	4
Report submission in Latex (as given in the format)	10.3.1	4
Budget for the project	11.3.2	4
Analysis of results	4.3.3	4
Deliver effective oral presentation	10.2.2	4

TABLE V
SUMMARY OF POST-INTERNSHIP SURVEY

Sl.no	Questionnaire for Post-Internship Survey	Mean
1	The objectives of the internship are well-defined. (1- Strongly Disagree, 5 -Strongly Agree)	4.24
2	The internship program demonstrated excellent organization (1- Strongly Disagree, 5- Strongly Agree)	4.3
3	The curricular internship facilitates the application of knowledge acquired throughout the course (1- Strongly Disagree, 5- Strongly Agree)	4.24
4	The assessment model proved suitable (1- Strongly Disagree, 5 -Strongly Agree)	4.15
5	The institutional physical environment is suitable for conducting internships (1- Strongly Disagree, 5 -Strongly Agree)	4.18
6	The internship setting is demonstrated to align well with the learning objectives (1- Strongly Disagree, 5 -Strongly Agree)	4.18
7	The institution's supervisor demonstrates technical and scientific competence in guiding the internship. (1- Strongly Disagree, 5 -Strongly Agree)	4.36
8	The internship enhanced my understanding of professional contexts (1 -Strongly Disagree, 5- Strongly Agree)	4.21
9	How satisfied were you with the session content? (1-Poor, 5-Excellent)	4.06
10	On a scale of 1 to 10, how would you rate your perceived personal growth and development throughout this internship experience?	7.53

To appreciate the industry internship program, a post survey after the program completion is taken. The questionnaire and corresponding mean achieved for the responses are detailed in Table V. The questions from 1-7 with a mean greater than 4 out of 5 indicate that the internship program is effectively structured and organized, with clearly defined objectives that meet the respondent’s expectations. The students were delighted with the resources and assessment strategies carried out in the program. The students expressed high satisfaction with the support from both the host organization and their supervisors at the internship-providing company and university. The responses to question eighth and ninth indicate that while participants found the session content satisfying, they perceived the internship as particularly effective in enhancing their understanding of professional contexts. The mean response of 7.53 for the tenth question suggests that, on average, participants perceive their personal growth and development during the internship experience to be relatively high. This indicates that the majority of participants felt that they experienced significant growth and development in various aspects, such as skills, knowledge, professionalism, and confidence, as a result of their internship experience, while the rating falls slightly below the midpoint of the scale (5.5) it still indicates a positive overall perception of personal growth and development. It is also essential to consider that personal growth and development are subjective experiences, and individual perceptions may vary based on various factors, such as the nature of the internship, the support received, and personal goals and expectations. Nonetheless, the relatively high mean response suggests that the internship experience has been valuable in fostering personal and professional development among participants. Overall, the student's accomplishments and feedback indicate the success of the internship program.

V. CONCLUSION

The industry-aligned IoT internship model demonstrated substantial success in equipping students with essential technical skills, enhancing their industry readiness, and fostering critical employability skills. This initiative, however, revealed several challenges that underscore areas for continuous improvement. One significant challenge was ensuring consistent engagement across the diverse skill levels within student teams. Addressing this required adaptive mentorship approaches, with tailored guidance to help bridge gaps in foundational knowledge, particularly in programming and hardware configuration. Additionally, logistical issues related to resource allocation—such as access to specialized IoT devices and cloud platforms—highlighted the need for stronger pre-internship preparation and resource planning.

Lessons learned from this initiative emphasize the importance of structured mentorship and continuous assessment in fostering effective learning outcomes. The collaboration between academic and industry mentors was pivotal in guiding students through real-world problem-solving, with iterative feedback loops proving beneficial for skill refinement. Future iterations of this program could focus on enhancing these mentorship components, possibly through more intensive pre-internship training modules to standardize baseline competencies.

Looking ahead, there are compelling opportunities to expand the program’s scope, particularly by integrating emerging IoT advancements, such as machine learning for IoT and edge computing. Additionally, broadening industry partnerships could enable access to a wider array of technologies, further aligning the program with evolving industry requirements. Continued emphasis on co-assessment by academic and industry mentors is essential for maintaining the program’s relevance and rigor. Future initiatives should also consider longitudinal studies to track career progression of program alumni, providing deeper insights into the long-term impact of industry-integrated learning experiences.

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