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Collaboration with Industry in designing Information Storage and management course

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Abstract: We live in a digital era deluged with huge data. An enormous amount of digital data is continually generated, collected, stored, and analyzed through software in the digital universe. The Industry-Institute interaction (III) is essential to innovate, inspire and envision the growth in the student's career in the digital transformation era. The goal of III is to bring together the practitioners at industry, professors and students to collaborate in forming a community that encourages innovation in order to visualize enhanced user experience. To provide solutions on various domains most of the organizations are providing storage solutions. Among these organizations DELL-EMC is one of the leading storage solution providers. Information Storage and Management (ISM) course is introduced in the undergraduate curriculum by collaborating with DELL-EMC. EMC's Curriculum on ISM course addresses the knowledge about storage technology emerging solutions. EMC Academic Alliance provides an opportunity to the students on ISM certification with free of cost. Based on these opportunities, ISM course contents are taken from EMC and course learning objectives are set according to the expectations of the industry. Authors have motivated the students by conducting online mock test on ISM certification. Through which students have got an exposure on writing certification exam. Certification exam on ISM is conducted and 50% of the students have qualified the exam with the target score of 85% at the semester end. This online certification creates an opportunity to the students to look for software jobs. Through this course we have mapped Department Program Outcome on Data Engineering criteria. With this course students have enhanced their skills in attempting online certification exams, which helps to build their career. By establishing the industry Alliance with DELL-EMC the authors are able to enhance the skills of students / next generation IT professionals on cloud technology, big data analytics and data storage.

Keywords: ISM, Certification exam, Storage, Data center.

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1. Introduction

The rapid proliferation of online social networking and Internet-enabled Smart phones and tablets has contributed significantly to the growth of enormous data. Data storage and its management is need of the data. The business organizations, educational institutions, banking system, online education system encounter the challenge of storing the legacy data and its protection. It is estimated that the digital universe produces approximately 4.4 trillion gigabytes (GB) of data yearly. With this analysis, it is projected that by the year 2020, the digital data will expand to 44 trillion GB. Individuals constantly generate and consume

information through numerous activities, such as web searches, e-mails, uploading and downloading content and sharing media files. In this digital era much of the user data and business data are in unstructured format. Approximately 90% of the data is unstructured and only 10% of the data is structured data [1] as shown in Fig 1. Structured data is stored in the form of rows and columns. To retrieve the data it is easier with rows and columns example airline reservation, telephone billing etc. But it is difficult to retrieve unstructured data because here data is not stored in a proper format for example documents, email, photographs, mortgage letters, X-rays etc. To manage such data we need a storage solution with faster and affordable cost. The challenges encountered in data storage are growth in the volume of data, compliance of data on the mobile devices and protection of the legacy data stored. One of the solutions for the data storage in the current days is the cloud infrastructure.

Data storage is the key component of the recent technology like cloud computing, big data analytics, machine learning, mobile platform and Internet of Things. The course ISM includes the different storage architecture components in the data center environment. The DELLEMC certification for students is included in the course. To prepare the students for the DELLEMC certification two mock exams are conducted. The percentile score of the student in the DELLEMC exam is considered for the continuous internal assessment with a weight-age of 10%.

Fig Data categories

The Industry-Institute interaction (III) is essential to innovate, inspire and envision the growth in the student's career in the digital transformation era. The goal of III is to bring together the practitioners at industry, professors and students to collaborate in forming a community that encourages innovation in order to visualize enhanced user experience. The different types of interaction that an education system can have in collaboration with industry are: Course design in collaboration with industry, Mini/minor projects in collaboration with industry, Capstone projects in partnership with startups companies/ industries, Internships and Memorandum of Understanding (MOU) in setting up the laboratory and providing training to the students in the expertise domain of the industry.

The author share the experience of teaming with DELLEMC and introduction of the course on "Information and Storage Management" (ISM) in the seventh semester, undergraduate curriculum of Computer Science and Engineering stream. DELLEMC is one of the leading companies that enables deliver of the services like storage, data analysis and management to the customers, with the adaptation of the cloud computing technology. It provides the professional certification framework and the exam road map for the students.

The paper is presented in a total of eight sections. In section 2 a literature survey of the different industry institute interaction is included; section 3 covers the course design in collaboration with DELLEMC, section 4, 5 and 6 elaborate on the course implementation, assessment and outcomes, followed by the result analysis and the conclusion.

2. Literature survey

The different form of collaboration with industry with institute to bridge the gap is presented in this section. Salas the author of , has proposed a model for interaction with industry and academy in the Mexican university. Here the student's tutorial committee is formed including the industry member that enhances the product quality development. The product prototyping is backed up with internal funding. The objective is to create entrepreneurs qualities in the students. The driving force is to create affluence in spite of the climate changes and shortage in energy generating resources.

Kim-Soon and et al , discuss about the university-industry collaboration in the Malaysian University. Three different types of interactions between University and industry are discussed. The first type involves indirect interaction, second type includes research elements and consultancies were as in third type the technical support is added. Third type helps to setup incubation center and patenting in collaboration with industry.

Ananthanarayanan and et al , focus on the III collaboration in the Indian engineering education. The parameters to assess the III are elaborated and improvement methods suggested. The six categories of III are mentioned. The evaluation of the category of III is performed both by faculty and students. Revana and et al , describe the involvement of participation of industry in the mini/major projects, internships, placements, apprenticeships, industrial visits, consultancies, research and development.

S. Nikolic and et al , bring out the collaboration of Student–Industry Interaction in the first year course of engineering, with the hands-on experience in the virtual world using video augmentation. The iSee video conferencing tool provides 3D view of users and dynamic formation of groups as in real life .

K. Ebato and et al , state the collaboration of University-Industry in research area Information security. The data set taken for analysis is from diverse group such as government, Industry, Non-profit organization and Universities. Draghici and et al , give the five different dimensions of collaboration of University and Industry for innovation towards economical development.

Kornfeld and et al , talk about the sustainability view point in collaboration of University and Industry. The authors discuss about the combination of technologies, business strategies, institutions and user practices in playing a role towards the sustainability and maintenance of the ecosystem. Fries and et al , state about the participation of industry in curriculum design of Biomedical engineering, career growth of students, in acquiring input for design/development and funding of the projects.

Nandikolla, Vidya, et al , described about joining hand with the industry in developing robotic design skills of mechatronics class, with the projects being open-ended. A sample project mentioned in the paper is to design a robot performing the tasks of attendant in the intensive care unit (ICU). The outcome based evaluation is used to assess the projects designed and developed along with the industry partners.

Abraham and et al describe the role of Industry Institute in Indian engineering education with the focus on information technology companies that contribute to the success. The interactions are categorized as basic, secondary and tertiary. Estelle Taylor , discuss about the involvement of industry in teaching the post graduate data warehouses course to bridge the gap between the industry and academy, so that the students are empowered to contribute in the working environment.

Agrawal, R. and et al [16] state the different challenges in handling the big data that is generated in the recent days. Data backup, data archiving, disaster recovery, data replication, data deduplication and business continuity are the different challenges in big data storage and management. The different storage architectures available are cloud services for storage, Network Attached Storage (NAS) for file sharing and object-based storage architecture.

N. C. Karmakar [17] discuss about the collaboration of the university at the research level. The author discuss the collaboration of industry in identification of the research domain, in setting up the research program, research outcome quality and the utilization of the research outcomes in the global market. The government support for research with funding is mentioned in the model described.

A. Katal and et al, [18] discuss the importance of information storage and management system. The concept of zoning, Logical Unit Number (LUN) masking and the different advanced storage techniques are described.

The authors gain the motivation from the survey to share the experience of the collaboration with industry in the course design and delivery.

3. Course Design

A course developed by DELL-EMC has been used as a basis for formulating the course in an Engineering curriculum.By aligning the academic curricula with industry practices & state of the art technology, a significant step can be taken to make the Engineering graduates "employable".

The course on ISM course is designed in collaboration with DELLEMC with the following goals:

- To bridge the gap between industry and academia
- To create awareness of the storage techniques
- To provide certification for enrolled students in the course

The proposed Industry Institute Interaction model is shown in Fig 3.1. Industry has provided necessary resources for effective delivery of the course designed. After the completion of the course online certification exam on this course is conducted. This certification provides lifelong validity that makes an add-on for the student placement.

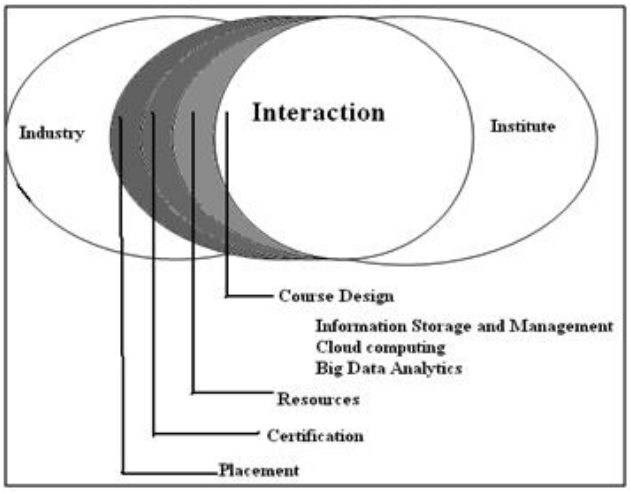

Fig. 3.1 Proposed Industry Institute Interaction Model

The course content includes the different components of the storage technologies such as storage over networking, Storage Area Network (SAN) based virtualization, backup techniques, archiving, remote replication, storage using cloud infrastructure and the security aspects of the storage system.

The course contents of the course are split into eight chapters. The first chapter includes the basics of the storage system, architecture, RAID (redundant array of independent disks) techniques and storage provisioning. The second and third chapters cover the concepts on networking technology for storage and virtualization which include fibre channel SAN components and Fibre Channel over Ethernet (FCoE). In the fourth and fifth chapter backup terminologies related to Business continuity, clustering and multipath architecture for failure points avoidance.

In the sixth chapter, storage techniques using cloud infrastructure is included. In last two chapters security issues related to storage system are covered. In the next section the course implementation, assessment and the outcomes are described.

1. Course Implementation

ISM course allows students to accomplish a widespread understanding of all fragments of storage technology. Following are the objectives of ISM course set inline with EMC Academic Alliance Program.

1. Utilize the third platform technologies like cloud computing, big data analytics, mobile computing and social networking to store and manage the data in the organization.

2. Upgrade the data center infrastructure using the technologies like software defined storage, virtualization, backup and recovery solutions.

3. Manage and secure the storage infrastructure in the organization.

Considering these objectives, authors have set the following Course Learning Objectives (CLO).

1. Illustrate the basic concepts of Information storage and management.

2. Elucidate different types of storage networking technologies like FC SAN, NAS and virtualization.

3. Depict backup, archive and replication in storage systems.

4. Select the techniques for securing and managing storage infrastructure.

5. Explore the recent storage technology solutions through survey.

These CLO's are set to meet the current needs of the industry and the organization. In collaboration with Dell-EMC the exposure on concepts such as Fiber Channel Storage area Network Configuration (FC-SAN), Internet Protocol Storage Area Network(IP-SAN), Host based business continuity, Intelligent Storage system and managing storage infrastructure is provided to the students. Through these concepts students have gained knowledge on the recent technologies used in storage and management of the data. Further subsection discusses about the activities carried out to meet the objectives set in this course.

A. Course activities

The activities conducted in the course have improved the concept learning and communication skills of the students. This also provided an opportunity to the faculties to strengthen the relationship with industry. As part of the CIE two minor exams and activities are conducted for this course. Activities implemented by authors are as follows;

· Quizzes

To enhance understanding level of the students on ISM course Quizzes are conducted and weightage is given for these quizzes. Quizze questions are prepared based on the concepts of part 1, part 2 and part 3 course content.

Following Table 1 shows the techniques involved in building storage technology solutions.

Sample quiz questions:

1. UNIX protocol for NAS device
   a) NFS b) CIFS c) iSCSI D) SCSI

2. In FCoE protocol stack data encoding & decoding supports in
   a)FC-0 b)FC-1 c) FC-2 d) FC-3

3. The space used by the VMM on the disk is known as
   a) page file b)swap file c) both a or b d) paging

4. Disk mirroring
   a) RAID 0 b)RAID 1 c)RAID 1+0 d)RAID 0/1

 MOCK Test

After completing the ISM course online mock tests are conducted to help the students to prepare for the actual certification exam.

 Dell-EMC Proven Professional Certification

At the end of this course DELL-EMC Proven Professional Certification exam is conducted for 54 students. The students are given an opportunity to attempt the online certification exam in the college. Planning is done for the conduction of the online exam in collaboration with DELL-EMC Corporation. The certification exam was on ISM-V2(Version 2).

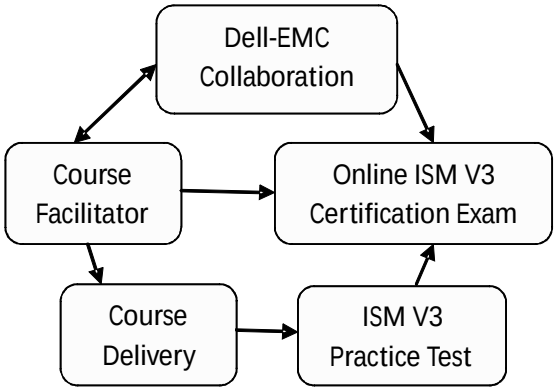

Fig 4.1 Online certification exam structure

4. Assessment Method

The assessment is having two parts Continuous Internal Evaluation (CIE) and Semester End Examination (SEE). In CIE student is assessed throughout the semester through course activities and two minor exams. The SEE is a written exam conducted at the end of the semester.

Table 1: Storage techniques and Solutions

Techniques	Solutions
Data center environment	• VMware ESXi
Redundant Array of Independent Disks(RAID)	• DELL/EMC CX SERIES • Initial Configuration
Intelligent storage system	• EMC VNX • EMC Symmetrix VMAX
Fiber channel SAN (FC SAN)	• EMC Connectrix • EMC VPLEX
Network Attached Storage (NAS)	• EMC Isilon • EMC VNX Gateway
Object based AND Unified Storage	• EMC Atmos • EMC VNX • EMC Centera
Backup and Archive	• EMC NetWorker • EMC Avamar • EMC Data Domain
Local Replication	• EMC SnapView • EMC TimeFinder • EMC RecoverPoint
Remote replication	• EMC Symmetrix Remote Data Facility (SRDF) • EMC MirrorView • EMC RecoverPoint
Storage Security	• RSA security • VMware vShield
Storage Management	• EMC ControlCenter • EMC Prosphere • EMC Unisphere

Evaluation is conducted for both CIE and SEE. Total of 100 marks is split with the weightage as, 50% to CIE and 50% for SEE. Current trends in storage technology solutions are evaluated in SEE and CIE. 15% weightage is given for Minor exam 1, 15% weightage for minor 2, 5% weightage for mock 1 certification, 5% for mock 2 and 10% for final certification exam. To assess their understanding, presentation and communication skills these activities are conducted.

The proposed ISM curriculum structure intended to accomplish the program outcomes described in Table 2. This table shows the attainment of department level PO attainment details with course outcome mapping.

Table 2 Assessment of POs mapped to CO's

PO's	CO's addressed	PO description
13.1	1,3,4	Demonstrate the knowledge required in the domain of data engineering to develop computer based solutions
13.2	2,3,5	Demonstrate the knowledge required in the domain of network engineering to develop computer based solutions.

5. Course Outcomes and Observations

This section discusses the result of various activities conducted for effective teaching of ISM course.

1. The real time scenarios shared with the students on the concepts on storage and management of data helped students to answer better in CIE and SEE.

2. The DELL-EMC certification exam has provided the experience of attempting the online certification exams to the students. The cut off for the certification exam is 85%. Out of 54 students, 50% of the students have qualified the ISM-V2 certification exam.

Table 3 presents outcomes of each activity carried out during this course.

Table 3: Activities and their outcomes

Activity	Outcomes
EMC Case studies	• Improved student's knowledge in understanding the concepts better. • Enhanced higher level of blooms taxonomy is achieved.
Real time Scenario	• Problem solving skills are developed in students. • Acquired acquaintance about how concepts are developed in real time.
Mock Test	• Gained knowledge about storage techniques. • Confidence level is increased to attempt the certification exam. • Preparedness to attempt certification is ensured.
EMC Proven Professional Certification	• Provides life time validity for better placement opportunities. • Motivation to take up other certification exams to enhance their skills.

A. Student's Reaction

Student's feedbacks for this course at the end of the semester were;

- Students' mentioned that EMC case studies taught in class helped them to understand the concepts easily.
- Students enjoyed the study of EMC products.
- Students have solved scenario based problems on real time environment.
- Better opportunity is provided to get certified for EMC Proven Professional Certification.
- Students gained knowledge about storage techniques and solutions.

B. Educator's Reaction

- Educator's perceptions at the end of the course are as follows:
- There were more useful class discussions and higher learning curves.
- Enhanced the affinity between faculty and students in the class.
- Blooms Taxonomy levels are focused during the assessment. Blooms Level 3 questions were increased in exams to strengthen the quality of the question paper.
- ISM version 3.0 is the latest update from DELL-EMC. Present semester course content of ISM V2

is replaced with ISMV3 in which the EMC Proven Professional Certification is conducted on ISMV3, which is incorporated in curriculum of 2017-18.

6. Result Analysis

The percentage attainment of the course outcomes obtained in the semester end examination for the year 2014-15 and 2016-17 described in the section 4 is shown in Fig 7.1.

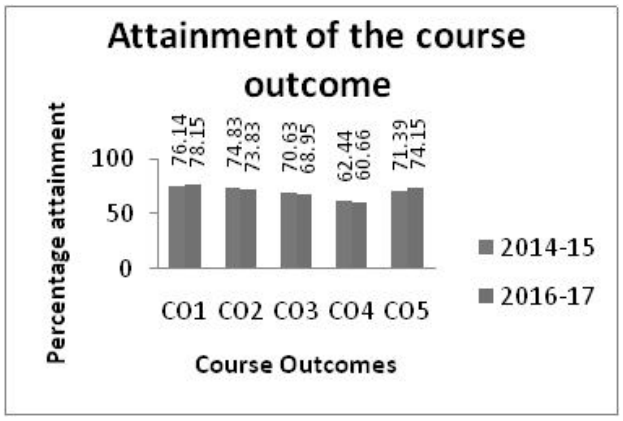

Fig 7.1: Percentage attainment of the course outcome

The Fig 7.2 depicts the performance of students in DELL-EMC certification exam for two academic years. The course is not opted during the year 2015-16. 50% of the students have qualified the ISM certification exam with the target score of 85% in the year 2016-17.

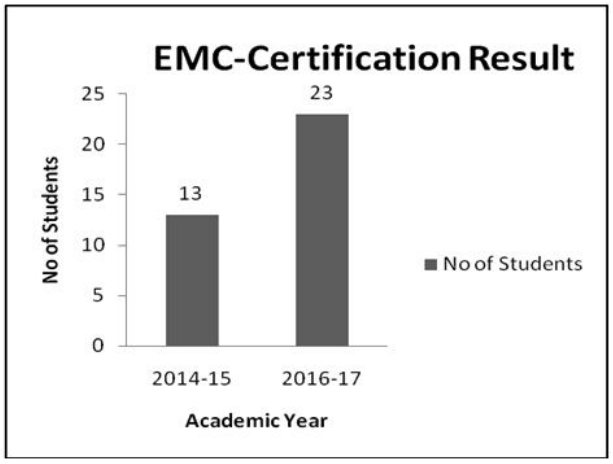

Fig 7.2 EMC certification result for two academic years

7. Conclusion

This paper presents the industry institute interaction to strengthen the curriculum. This interaction enabled to bridge the gap between the industry and academia. The design of the course on ISM in collaboration with DELL-EMC provided the opportunity to build the skills in the students on storage technology. In the digital era enormous amount of data is generated. Concepts learnt in this course made the students to understand the storage architecture and data center environment. This paper describes course objectives, course design, implementation and assessment method. The certification conducted in this course has provided the lifetime opportunity to build their career. This course made the students expertise in meeting the challenges of data storage and management. The main objective of this course is to build storage professionals.

Acknowledgement

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