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SKILL ACQUISITION FOR ENHANCING EMPLOYABILITY THROUGHMULTIPLE LEARNING EXPERIENCE INSTRUCTIONAL STRATEGY (MLEIS)–TOWARDS ENSURING INCLUSIVE AND EQUITABLE TECHNOLOGY EDUCATION

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Abstract:
Matching skills to jobs has long been one of the important goals of education. The National Employability Report (2016) has highlighted the fact that engineering graduates do not fulfill the basic criteria of employability. It has been reported the current strategies do not address multiple modes and levels of numeracy, programming, computer literacy, algorithm and programming. It was revealed that students find certain subjects quite difficult and the objective based achievement test revealed failure to realize learning objectives and learning outcomes. Theory based instructional strategies and lecture mode of instructional delivery has been found to be not suited for engineering education [1].In this study, the effectiveness of a Multiple Learning Experience based Instructional strategy (MLEIS) is explored. MLEIS is based on theories of learning, instruction design, learning styles and techno pedagogies. MLEIS envisages a skill based curricular strategy which addresses diversity, inclusiveness focusing on aspects like skill development, skill acquisition, professional competency and subject comprehension.

Keywords: employability, multiple learning experience instructional strategy (MLEIS), inclusive and equitable, technology education

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1. Introduction

> *"For Students to learn in a meaningful manner they must be actively engaged in the learning process"* Richard Felder [2]

How well students learn in the learning place, equips learners with skills of global citizenship. These get transferred to the work environment. *"The current global scenario requires engineers to be global citizens, as well as aspirational, ethical leaders."* [3]

Also, there is little evidence that contemporary college students are gaining more than past generations of students in terms of higher-order thinking skills [4]. Studies have revealed that multi instructional strategies contribute towards equipping learners with skills of problem solving and higher order thinking. Almost all subjects prescribed in the technology education curriculum at Postgraduate level requires foundational knowledge as well as multidisciplinary competency of numerical methods, computer literacy, algorithm design, data structures and programming. Studies have revealed that lecture and teacher centered strategies are not suited for many subjects [5].

Foundational subjects like Theory of Computing, Number Theory and Algebra, Problem solving and Programming in C is concerned with foundational aspects of Computer Science viz., Using compilers, command lines, editor's, build tools, integrated development environments, Programming and algorithm design, data structures. It is also concerned with mathematical applications that form the bases of Parallel computing, threads, message passing paradigms, Version control, Debugging, Basic numerical methods such as quadrature, Gauss Elimination, finite difference approximation to derivatives and Iterative methods such as Newton's method for nonlinear systems; Jacobi and Gauss-Seidel solvers, the Conjugate Gradient and GMRES methods for linear systems; preconditioning, Finite element/ difference/ volume methods, Fast Fourier Transform (FFT) and fast multiple methods

Most of the subjects prescribed in the syllabus are interdisciplinary subjects and thus multiple pathways of instructional strategies are most suitable for building competency in concepts related to interdisciplinary subjects. Applying concepts of mathematical modeling to problems in the sciences and engineering is the focus of many engineering subjects. Multiple instructional strategies are ideal for teaching the various components, phases, levels which encompasses varying degree of abstractions and logical thinking. Given the disparity of these topics, teaching an computer related course therefore presents challenges and opportunities different from many other science, technology, engineering and Mathematics (STEM) classes [5] Studies have reported that a linear arrangement of material throughout the semester or year is not useful for student learning. Classroom practices play an important role in the transaction of curriculum. All school policies and curricular objectives are being realized within the four walls of the classroom. Classroom practices involve and incorporate classroom dynamics, classroom communication, classroom dialogue, teaching learning process. The wealth of studies of effective teaching conducted over the last few decades, has now clarified the basic nature of the many process variables, involved in teaching ranging from discrete observable behaviors to more global and more subjectively assessed qualities [6].

Research studies have emphasized the importance of classroom activities for students and teachers. Goals of effective teaching may emphasize cognitive (intellectual) aspects of learning or affective (social, emotional and attitudinal) aspects of learning. They may emphasize short term goals (achievable by the end of lesson or long term goals achievable at the end of the course or even later the paper proposes an Instructional strategy which envisages multiple pathways based on different domains catered to enhancing diverse skills and involving a range of learning experiences. Studies have reported that the extent to which learners engage in learning contribute to effective learning. Studies have reported that modern day classrooms are a heterogeneous and diverse learning environment which caters to differentiated instruction, individualized instruction and self-paced instruction [7]. The Multiple learning pathways required in this context calls for multiple teaching and instructional pathways. Review of literature has revealed similar conclusions arrived in this regard. The Tata class edge referred to as the Multiple Learning Experiences (M-LEx™) Model makes use of Multiple Models of Integrated learning [8].

Table 1: Module wise Objective based learning framework

	Outcomes	**Activities**	**Objectives**	**Module no and description**
Understanding of concepts	Teacher centered lecture mode	Acquire familiarity with concepts and architecture of Supercomputing	**Introductory and Foundational Concepts**	Module 1 6 hrs
Enriching knowledge	Digital resources, Multimedia lectures	Understanding of mathematical basis of computing	Declarative and procedural concepts	Module 2 3 hrs
Activity centered	Problem solving based tutorials	Understanding of Logical basis of computing	Associated concepts	Module 3 3 hrs
Skills of problem solving	Problem solving based tutorials	Application of Grid computing	**Applied Concepts**	Module 4 6 hrs
Skills of Collaboration, and Negotiation	Project conceptualization, development implementation and execution	Familiarity with Industry based real time live projects Association with real time live projects	Practical and hands on sessions	Module 5 6hrs

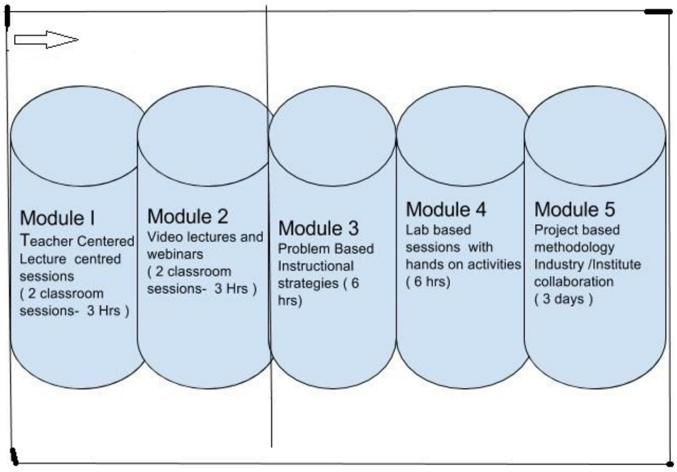

Figure 1

The instructional procedure for the whole semester is highlighted in figure 1. The diagram illustrates the different instructional strategies proposed which covers a period of 18 hrs instructional time and 18 hrs industry/institute collaboration categorized over 5 multisensory instructional strategies commencing from the Teacher centered lecture method to activity based problem based and project based strategies which culminates in student centered seminar presentation of projects and submission of a project report.

2. High Performance Computing

The course HPC taught every even semester is the context of this paper. The primary purpose of the course is to familiarize students with the practical applications of the HPC and its industry applications. The course is a hands-on, project oriented course covering advanced concepts of algorithms, parallel computing, grid computing and cloud computing .

Typical enrollment consists of 15–20 students representing most science and engineering programs (including mathematics). Students taking this course generally have some background in Mathematics and computer Science. Theoretical foundations of computation are a prerequisite for the course study and rarely do students have a practical perspective. Few students have programming experience beyond brief Mathlab scripts and none has worked with software systems as large as deal, the widely used open source finite element library that serves as the foundation for this course [9-10].

To provide students with a deep understanding of concepts related to Mathematics, Programming, Coding, Algorithm and Practical applications in HPC, the course is structured around Multi instructional strategies commencing from Teacher centered Lecture mode, Teacher facilitated problem solving methodologies and in the latter phase industry collaborative project based methodology is deployed. The different learning methodologies imply diverse learning environments and experiences. A final report and final presentation is submitted by the students at the end of semester. The particular instructional strategy is deployed because the particular course does not pertain to any pre requisites and many of the concepts are introductory concepts presented during the course of the session. The course meets twice weekly for 2 sessions of 3hrs each and a lab session of 2 hrs per week. The lab topics was dealt as part of classroom session

3. Approach

In our search for a strategy to resolve the challenges of time management, broad content, and intensive student projects, we redesigned the course to incorporate a Multi tracked instructional strategy enabling diverse learning environments, learning experiences and learning activates in a single module so that after the completion of the module the student is familiar with concepts, has identified the concepts, is able to apply the concepts, is equipped with skills in problem solving and is familiar with problems in real environment,

Multiple Learning Experience based Instructional Strategy (MLEIS) has been structured around the premise that the variety of learning engagements and instructional strategies stimulate diverse learning experiences which enable better learning reinforcement and retention at the beginning of the course the students enrolled for the course are homogeneous. This is true for certain courses where prerequisites are not required viz., introductory concepts like HPC [11].An MLEIS curricular design is an experiment in classroom dynamics which is an instructional design proposed that requires students to experience multiple diverse learning engagements for the same content in different contexts. These will contribute to reinforce learning and help in greater retention of concepts.

For the current study**, the curricular framework based on MLEIS** is proposed for a Postgraduate course of Engineering Education. There are a total of 5 courses per semester. The curriculum prescribes 5 modules for each course. Five modes of instruction have been envisaged for each module which was defined by the nature of content. The Topics in the first module are mostly introductory and foundational concepts. The learning objective is to acquire familiarity with concepts and first principles of the Topic highlighted. To teach interlocutory concepts, Teacher centered methodologies like lecture mode have been found to be very effective [12]. Studies have revealed that introductory concepts are best learnt in group instructions and by means of teacher centered lecture methods. Lecture methods enable scope for discussion and deliberation in real time live environments which contributes to direct learning experiences and opportunities for exposing and eliminating misconceptions. Despite several generations of harsh criticism, lecturing remains one of the most common, and often one of the most effective, means of teaching. At its best, a lecture enlivens academic subjects with the instructor's energy and curiosity and with the persuasive nuances of human speech. Nevertheless, lecturing has its limits, most notably the reputed twelve-minute average human attention span, the difficulty of representing complex material verbally, and the awkwardness of presenting diverse, multimedia sources [13].

For the second module, **Problem solving methodologies** may be deployed. For example for teaching High Performance Computing problem solving techniques of Parallel linear algebra routines, Loop optimizations. Implementation, Principal of Locality, Understanding of mathematical basis of computing Digital resources, Multimedia lectures Enriching knowledge are appropriate technologies. Involved practice sessions by means of problem solving. Studies have revealed that drill and practice, tutorial sessions provide opportunities for higher order understanding and equipping learners with problem solving skills [14]. Introductory concepts are best learnt in group instructions and by means of teacher centered lecture methods. Lecture methods enable scope for discussion and deliberation in real time live environments which contributes to direct learning experiences and opportunities for exposing and eliminating misconceptions [15]. More effective teaching methods in introductory courses will result in a higher retention rate of early students, while the precise mechanism behind the effectiveness of PBL has not been determined [16].

For the third module, the **digital resources in the Multimedia lab** were utilized by students to review the lessons and content learnt in the classroom. Watching content videos or otherwise engaging with the course material through content-based videos generated and presented through sites such as the Khan Academy [17], Coursera [18], MIT Open Courseware [19], and iTunes [20] is a means to better students with diverse learning styles or preferences [21]. Studies have also revealed that increased interactivity in the classroom improves student learning outcomes [22].

For the fourth module, **Activity based sessions and Hands on activities** were envisaged. Understanding of Logical basis of computing Problem solving based tutorials Activity centered. Algorithms and optimization require involved practice sessions by means of lab activities. Studies have revealed that drill and practice, tutorial sessions provide opportunities for higher order understanding and equipping learners with problem solving skills [14-15] argues that more effective teaching methods in introductory courses will result in a higher retention rate of early students. While the precise mechanism behind the effectiveness of PBL has not been determined [16].

For the fifth Module involved familiarity with industry based real time live projects Association with real time, live projects project conceptualization, development implementation and execution Skills of Collaboration, and Negotiation Computing Platforms: **Network Interfaces, Grid Scheduling, Resource Management Security, Accounting and Assurance.** Studies have revealed that collaboration with industry exposed students to real world problems and enabled them to be acquainted with projects being undertaken in industry. This collaboration with industry will enable them to be equipped with work skills and prepare them for the work environment according to the 21st century skills of the learner- skills of communication, collaboration and negotiation have been identified as important skills.

4. Feasibility of the Intervention

The success of a new approach to teaching a class lies in the degree of engagement with learning whether students learn more, learn more deeply, retain more knowledge or understanding, or simply enjoy class more. The MLEIS Curricular framework is based on sound pedagogical theories of instruction and research findings on effective instructional practices. The researchers are confident that Multi-instructional approaches will contribute towards skill acquisition and will pave the way to matching skills to jobs which has long been the important goals of education. This approach will also help in fulfilling the basic criteria of employability of engineering graduates.

The MLEIS approach makes the curriculum integrated, systematic, catering to diversified and differentiated instructional designs and contributing to inclusiveness, integration, deep learning and engaged learning.

In an attempt to study the feasibility and practicability of MLEIS approach an Institute Industry Partnership Initiative (IIPI) was envisaged. Under this initiative, students were given flexibility to engage with industry and partnership with them in the course of fulfilling the requirement of Mini project. Students selected a problem faced by industry for their Mini projects and in partnership with academia and corporate gained knowledge and hands on training in real world work environments.

The opinion of the students who participated in IIPI was investigated by a survey method. The responses were analyzed and the details are given in Figure 3 and Figure 4.

5. Results and Discussion

The MLEIS approach (Figure 1) strives to contribute to diverse learning styles and addresses heterogeneity of the student community in the classroom. The framework reveals necessity of well-planned curricular design, availability of resources, adequate infrastructure, cooperation of faculty and willingness and need of companies (Table 1).

The results in Figure 3 reveal the majority opinion with regard to reasons cited by students for giving their consent to participating in IIPI. The majority of students (Figure 3) have cited the reason that they have participated to acquire work skills. The study of student expectations revealed that majority of students expected to gain work experience and were looking for experience to network.

6. Conclusions

The approach to teaching taking into account diverse and multiple learning pathways promises to provide at least the following three, important benefits: (1) helping students engage deeply with course content, (2) increasing motivation, independence, and perseverance, and (3) facilitate more communication with the course instructor. As Outlined in the previous sections and supported by student quotes, we believe that the format succeeded in realizing these benefits.

The experience we have with this class format is therefore largely positive and we will continue to use and refine it. In particular, this pertains to the use of reflective writing, which we continue to believe to be a very useful tool if used appropriately.

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Appendix

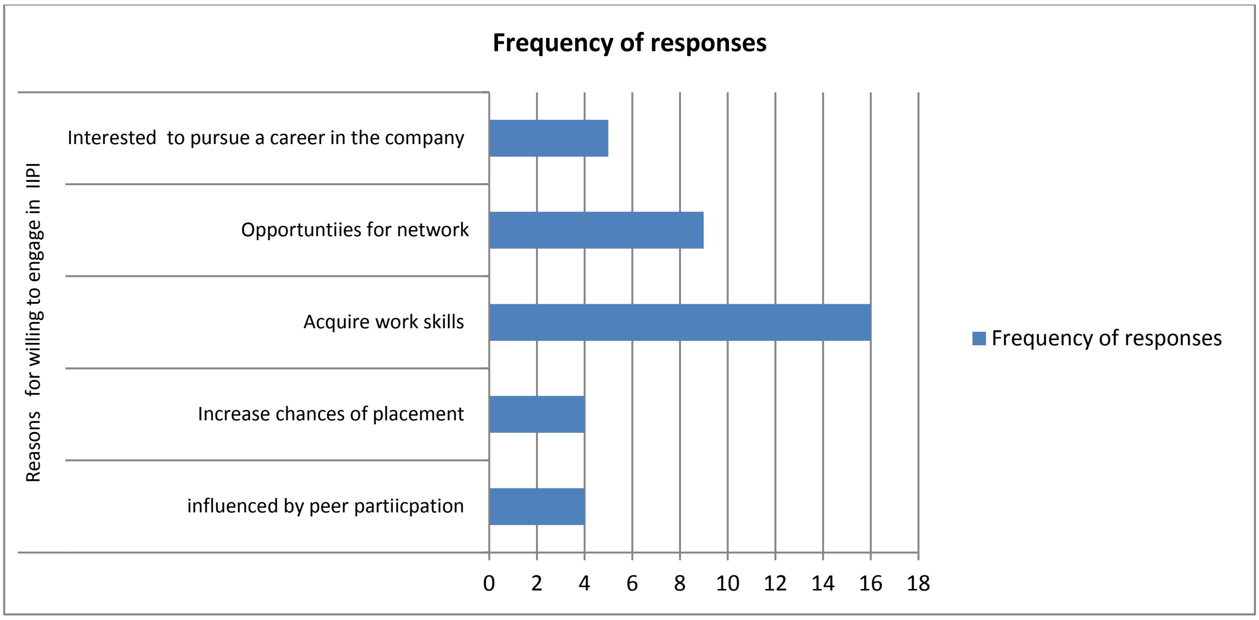

Figure 3: Response of students – Reasons cited for joining Institute-Industry Partnership Initiative

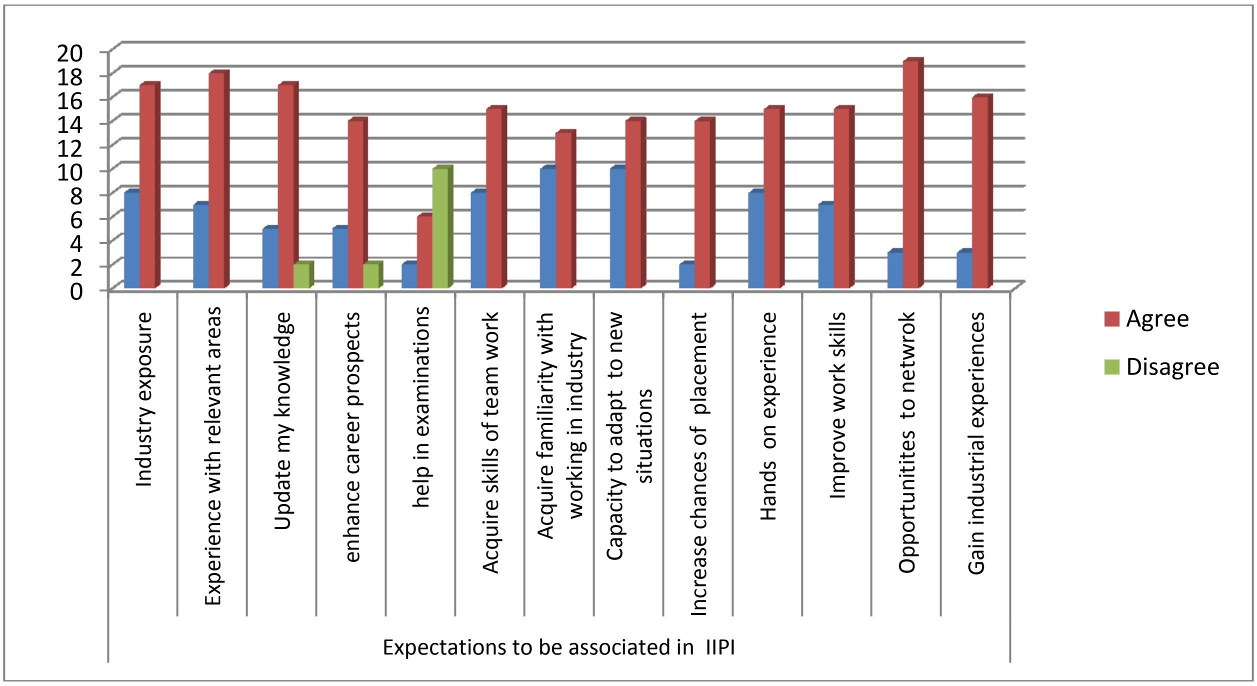

Figure 4: Expectations of learning outcomes on Institute-Industry Partnership Initiative