Teaching and Learning in Engineering (TALE)
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Lecture - 01
Overview of TALE and Good Engineer

Greetings to all of you. Welcome to the course TALE, Teaching and Learning in Engineering and the first unit is concerned with not only teaching and learning in engineering but also the characteristics of a good engineer.

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Need

- Shift to learner centric education
- Accreditation and Outcome Based Education (OBE) became the foci of higher education in India since 2015.
- Most of the higher education institutions (HEIs) offering UG and PG programs in engineering want their programs to be accredited by the National Board of Accreditation (NBA).
- NBA requires, since 2015, all engineering programs attain the Program Outcomes, and demonstrate that they are continuously improving their performance.

Now, since 2015 there have been major changes in the field of higher education. The major shift is related to from teacher centricity to learner centricity. What it means is, the focus is on what the learner should learn and to what extent he has learnt. That is what we mean by a learner centricity. And learning is measured in terms of to what extent a specified outcome has been attained by the student.

Or saying that the level of achievement of outcome is the basis for planning and implementing instructs. Now the major change is in the process of accreditation. What accreditation means the some agency will measure to what extent a program that is conducted meet certain specified criteria. These criteria are generally defined by an agency of the government in case of

engineering education, it is National Board of Accreditation and in case of general programs it is NAAC.

And what do they do? The national board of accreditation defines a set of criteria and actually assesses to what extent the particular program is, to what extent the program is making the specified criteria. Why is this necessary? After all any educational institution, private or public is a social institution. There are several stake holders concerned with that, anywhere from students, teachers, and then you have parents, then you have government agencies, universities and so on.

And the stakeholder should be made aware of to what extent this particular social institution is meeting its stated objectives. And the process of accreditation really serves that purpose. In coming to the specific higher education, most of higher education institutions offering UG and PG programs in engineering they would expect their programs to be accredited by the National Board of Accreditation.

The engineering programs, both at UG and PG level come under the purview of National Board of Accreditation - NBA. And NBA since 2015 requires all engineering programs attain the program outcomes and demonstrate they are continuously improving their performance. We will, here we define the, use the word program outcomes a little loosely but we will elaborate a little later what they are.

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Need (2)

- Many HEIs also wish to have their institutions accredited by NAAC (National Assessment and Accreditation Council)
- All teaching and learning activities in HEIs should be planned and conducted to facilitate the students to attain well defined and measurable Outcomes (OBE). This is a new requirement for all faculty members of engineering colleges.
- TALE is designed to facilitate teachers meet these requirements.

Many of the higher education institutions also want to have their institution accredited by NAAC. NAAC is National Assessment and Accreditation Council. The difference is National or the NAAC wants only the institutional accreditation while they look at some programs in detail, but they want a whole bunch of other characteristics of the institute to be reviewed and evaluated.

And all teaching and learning activities in higher education institution should be planned and conducted to facilitate the students to attain well defined and measurable outcomes. And this is what we broadly call it as outcome based education. And this is, this particular requirement of having OBE is a new requirement for all faculty members of engineering colleges as their earlier activities were not directly related to this.

They are not in opposition to this but they are not perfectly in alignment with outcome based education. Now, TALE is a course that is designed to facilitate teachers to meet these requirements.

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TALE

- This course aims at enabling the teachers in engineering programs to facilitate their students to become good engineers at the time of graduation
- The course is offered as four Modules:
  - Learning Outcomes
  - Course Design
  - Instruction
  - Accreditation
- Each module constitutes one credit
- Each module is offered as 20 units of about half-hour video lectures
- Each Unit will have a set of assignments

Now TALE aims at enabling the teachers in engineering programs to facilitate their students to become good engineers at the time of graduation. That is what any engineering program should aim at, has been aiming at. The course is offered as 4 modules, learning outcomes, course design, instruction, and accreditation. Each module constitute one credit load which is approximately equal to, equivalent to about 10 classroom sessions.

Each module is offered as 20 units of about half hour video lectures and each unit will have a set of assignments. This is the structure of the TALE.

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This course will be useful to

- Working teachers in engineering colleges
- Aspiring teachers
- Graduate students who wish to make careers in education technology
- Companies offering education technologies and training programs to corporates, educational institutes, teachers and students.

Who is, who will have interest in the course called TALE? Most importantly the working teachers, either the experienced or newly recruited teachers in engineering colleges, aspiring teachers, those who are outside the teaching profession and want to get into this and also graduate students who wish to make their careers in education technology. And there is a tremendous amount of corporate training these days.

Even the company is offering education technologies and training programs to corporates, educational institutions, teachers and students. Such companies will also be interested in this course.
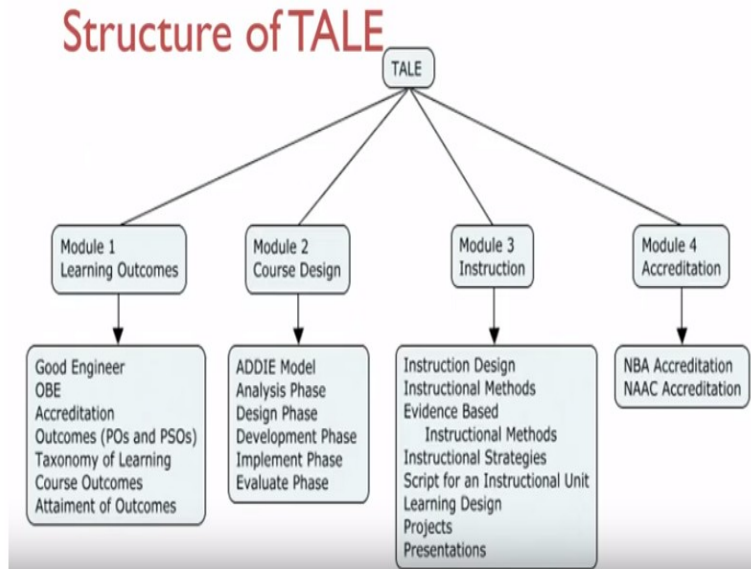
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Acknowledgements

• Gratefully acknowledge the inputs and comments given by Prof. K. Rajanikanth.

I would like to particularly acknowledge the inputs and comments given by my friend, Prof. K. Rajanikanth whose inputs are, have been very very valuable to me.

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Structure of TALE

Now, let us look at the structure of the TALE. Module 1 is, we titled it as "Learning Outcomes". This will look at issues like who is a good engineer, what is outcome based education, the accreditation, outcomes themselves how they are classified and taxonomy of learning, how to write course outcomes and broadly how do you measure the attainment of outcomes. These are the elements of module 1. These will be covered or addressed over about 20 units.

Module 2 is "Course Design". This course design process assumes the knowledge of module 1 and the course is designed in the framework of ADDIE Model. ADDIE Model has 5 phases. A analysis phase, design phase, development phase, implement phase, and evaluate phase. The course will look at how to look at each phase in detail and we will try to present a kind of a template for each phase for designing the course.

And module 3 is related to "instruction" and we will talk about instruction design and instructional methods, evidence based instructional methods particularly instructional strategies which are nothing but a collection of instructional methods, script for writing an instructional unit and what we broadly call as learning design and then also look at instruction for projects and presentations. Module 4 is related to "accreditation". It can be NBA accreditation as well as NAAC accreditation.

Because these days engineering institutions are not only interested in NBA accreditation, they are also seeking NAAC accreditation. So broadly that is the structure of the course TALE.

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Course Outcomes (TALE)

At the end of this course (four modules) the students (practicing and aspiring teachers) should be able to

Module I

CO1. Understand the nature of Outcome Based Education, and Objectives and Outcomes of an undergraduate program in engineering as required by National Board of Accreditation.

CO2. Understand the Anderson-Bloom-Vincenti Taxonomy, and the three domains (Cognitive, Affective and Psychomotor) of learning.

CO3. Write outcomes of a course in an engineering program that address a subset of Program Outcomes and Program Specific Outcomes.

Now as we are talking about outcome based education without talking about the kind of statements that one should write as course outcomes, we will mention what the outcomes we are trying to attain. At the end of this course, that is after the 4 modules, the students, here the learners are practicing and aspiring teachers should be able to in module 1 understand the nature of outcome based education and objectives and outcomes of an undergraduate program in engineering as required by NBA.

So broadly that is the one of the first course outcomes that we have. And we require some kind of a language to communicate between the learners and that is where we talk about the taxonomy. The particular taxonomy of learning that we are looking at will be called Anderson-Bloom-Vincenti Taxonomy. So the course outcome is: Understand Anderson-Bloom-Vincenti Taxonomy and the three domains of learning.

The course outcome three then we learn how to write outcomes of a course in an engineering program that address a subset of program outcomes and program specific outcomes. So these are the three course outcomes of the module 1.

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Course Outcomes (2)

Module 2

CO4. Design a course in an engineering program in the Instructional System Design framework of ADDIE.

CO5. Design assessment that is in good alignment with course outcomes.

Module 3

CO6. Design instruction following Merrill's principles for attaining the course outcomes and competencies ensuring good alignment between course outcomes, assessment and instruction.

And module 2 looks at designing a course in an engineering program in the Instructional System Design framework of ADDIE. And also specifically we emphasize designing assessment that is in good alignment with the course outcomes. And module 3 is design instruction following Merrill's principles which we will elaborate at that time for attaining the course outcomes and competencies ensuring good alignment between course outcomes, assessment and instruction.

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Course Outcomes (3)

Module 4

CO7. Prepare for NBA accreditation at the Department level.

CO8. Prepare for NAAC accreditation at the institution level .
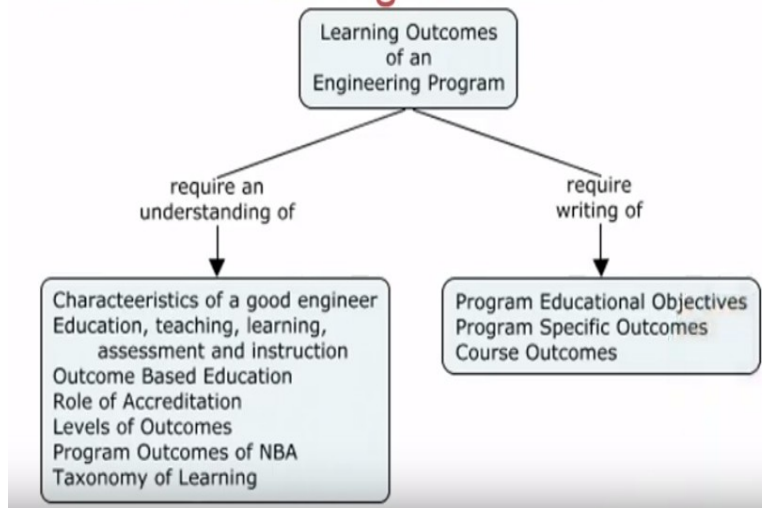
Module 4 prepare for NBA accreditation at the department level and CO8, course outcome 8 prepare for NAAC accreditation at the institute level. So these are the course outcomes of TALE.

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Module 1: Learning Outcomes   *

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                    Learning Outcomes
                          of an
                   Engineering Program

         require an                          require
       understanding of                     writing of

   Characeristics of a good engineer    Program Educational Objectives
   Education, teaching, learning,        Program Specific Outcomes
        assessment and instruction       Course Outcomes
   Outcome Based Education
   Role of Accreditation
   Levels of Outcomes
   Program Outcomes of NBA
   Taxonomy of Learning
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Now coming to module 1 a little more specifically, learning outcomes of an engineering program, first require an understanding of characteristic of a good engineer, education, teaching, learning, assessment, and instruction. Then we look at outcome based education. Then we look at role of accreditation, levels of outcomes, program outcomes of NBA. We take considerable time in trying to understand the nature of the program outcomes of NBA, then taxonomy of learning.

Then based on this knowledge, we what you call, we write Program Educational Objectives, Program Specific Outcomes and Course Outcomes. The particular meaning of these three types of outcomes, we will look at it at a later stage.

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What do engineers do?

- Groups of engineers and non-engineers solve socially relevant complex technical problems.
- Engineers architect/plan, design, develop, manufacture, test, install, operate, and maintain technological products and systems.
- Engineers are involved in wealth generating activities.
- Engineers provide services using technological products and services

Engineers are required to operate and behave within well-defined professional and ethical standards.

And now coming to actually what do engineers do, we want to understand who are good engineers? Before we go and understand what are good engineers but actually look at what do engineers do. Let us change the sequence a little bit. Engineers broadly architect or plan, design, develop, manufacture, test, install, operate and maintain technological products and systems. Of course, any single engineer will not be doing all these activity.

Maybe at different points in his career he may be involved in these activities, but by and large at any given time he is involved in one of these activities. And all these activities will have to lead to some wealth generation for the organization for which he is working. And again engineers not only perform all these activities, sometimes engineers provide services using technological products and services.

They provide services on for example you take a electric supply or water supply, the engineers will have to make sure right kind of services are provided on these products. Again, coming to the first one, actually engineers very rarely work in isolation. Always any activity, engineering activity will involve a group of engineers, either at the same level of competency or sometimes organized in a hierarchical fashion along with some non-engineers they solve socially relevant complex technical problems. That is what the engineers do.

But while doing all these they are required to operate and behave within a within well-defined professional and ethical standards because every professional organization has certain requirements of behavior and these are enunciated as professional and ethical standards. So all engineers are required to work within them.

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Good Engineer

Characteristics of a good engineer considered important by the industries

- Having sound knowledge of engineering sciences and technologies
- Ability to solve well defined and ill-defined problems.
- Awareness of customers' needs and market trends.
- Ability to work in a team.
- Ability to document, plan and communicate effectively.
- Willingness and ability to learn on the job.
- Having an interest and awareness in all facets of engineering activities

And now we come to trying to understand who is a good engineer? Where do we find who is a good engineer? It is generally because engineers dominantly are employed by industries and we go and consult really the top worldwide or well-known respected industries and ask their CEO's or their managers to say whom do they consider somebody as good engineer? And this kind of surveys have been done fairly many times. Because as the technology changes as the requirements change what is considered good engineer may also keep changing with time. So this is a kind of a summary of what they consider as the characteristics of a good engineer. Some companies may consider something as a higher priority than what is indicated but these are indicative, not necessarily arranged in a particular hierarchical order.

But all of them will start with say all good engineers must have sound knowledge of engineering sciences and technologies, on that there is absolutely no second opinion about it. There is no substitute for poor knowledge of engineering sciences and technologies. Then come the other one namely ability to solve well-defined and ill-defined problems. Because in an educational institution we are likely to get trained in solving dominantly well-defined problems what we call end of the chapter problems or the kind of examination problems that we ask.

But in real world problems are never that well defined. So one should be able to tackle an ill-defined problem and convert into a well-defined problem. That process is not very simple and which involves many assumptions which may be valid or not valid. So the first two are truly

what you call disciplinary in some sense disciplinary requirements. Then another characteristic of a good engineer, awareness of customer's needs and market trends.

Anything that an engineer does, he is to meet somebody's requirement. Either government is meeting the general public's requirement or a company is trying to make certain services and products available to customers. So the one of the requirements of any good engineer is that awareness of customer's needs and market trends. Even if one designs a beautiful product and it is not relevant to the current market trends, the product has no chance of getting accepted by the market.

And next one is ability to work in a team. As we mentioned earlier, engineers always work in teams. So there is no question of anyone working in isolation. So one should be able to work in a team which requires its own skills, to work in a team one cannot take a very hard independent stand and that one should learn to work with others. Then come the ability to document plan and communicate effectively.

Unfortunately this is in Indian context most what do you call considered least important. Somehow many engineers consider documentation is something or communicating is a secondary requirements and the primary requirement is to solve the problems. But if you look at if you ask many companies, they consider this ability to document plan and communicate effectively - fairly at the top.

And with technologies continuously changing and market trends continuously changing what you learn during the 4 years or 2 years of post-graduation is not going to be adequate. You cannot stop your learning after the a formal program. You have to learn continuously on the job. So willingness and ability to learn on the job is one of the important requirements.

And finally having an interest and awareness in all facets of engineering activities. One should be aware of all the other facets. An engineer's work does not end with designing something, testing something and documenting it. One should be aware of what are all its facets and these are broadly the characteristics of a good engineer. What National Board of Accreditation has

designed, has affectively absorbs all these characteristics of a good engineers and characterizes them as required outcomes of an undergraduate programs and calls them as program outcomes. We will see the 12 outcomes that have been stated by NBA in another unit.

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Engineering Programs

are required to impart
- Knowledge
- Skills
- Attitudes

and to facilitate the graduates of 12th Standard
- to acquire the characteristics of a good engineer

Now all engineering programs are required to impart knowledge, skills and attitudes which will be stated as program outcomes and to facilitate the graduates of 12th standard, that is the entry point to engineering program to acquire the characteristics of a good engineer. That is what an engineering program ought to be, okay.

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Assignments

- Who is your favourite "good engineer"?
- Why do you consider him/her a good engineer? (Write 250 to 400 words)

Now, what we will look at is an assignment. The assignments will serve a great purpose of exploring a little bit beyond what has been presented in the lecture. For example we talked about what are the characteristics of a good engineers? Can you identify or you identify your favorite good engineer. You can look at, there is plenty of literature available on the net, on the internet. You can identify and select your favorite good engineer and then write a few words anywhere from 250 to 400 words why do you consider him or her a good engineer. So those are the assignments at the end of the first unit.

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MIU2

- The Unit MIU2 attempts to reintroduce the familiar words "education", and "teaching".

And then we move on to in another unit M1U2. M1U2 attempts to reintroduce the familiar words education and teaching. These are words, education and teaching are something that everybody is familiar with but many times they are used a bit interchangeably or ambiguously and so on but as a teacher one is required to have a clear understanding of the words "education" and "teaching" which we will explore in the following unit. Thank you very much for your attention.