

Teaching and Learning in Engineering (TALE)
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Lecture - 03
Learning, Instruction and Assessment

Welcome to the module 1 unit 3 which is related to three familiar words namely learning, assessment and instruction.

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Recap

- Education is intentional learning and is what the society deliberately transmits (its accumulated knowledge, values and skills considered necessary and desirable for a profession from one generation to another) through educational institutes
- Teaching is facilitating learning through interventions by the teacher. The nature of interventions is based on the preferences of the teacher, nature of the subject and the context.

These are what we were doing in the previous unit, we looked at the words education and teaching. Education as we noted is intentional learning. Generally that is decided by some agency of the society. Wherein in education really refers to transfer of accumulated knowledge, values and skills considered necessary and desirable for a profession from one generation to another. And this is normally done through some designated institutions. It could be a school or a college or a university. Whereas teaching is facilitating learning through some interventions by the teacher. These interventions can be many but the choice of this intervention is based on the preferences of the teacher, or the nature of the subject and the context. So there are a large variety of types of interventions that can be brought in by the teacher.

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MIU3: Outcomes

MIU3-1: Get reintroduced to the familiar words “Learning”, “Assessment” and “Instruction”.

MIU3-2: Understand the centrality of assessment in facilitating good learning.



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Now coming to our present unit, there are two outcomes. One is again we try to get introduced to the familiar words, “learning”, “assessment” and “instruction” and also try to understand the centrality of assessment in facilitating “good learning”. These are the two major outcomes that we are trying to attain.

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Learning

- Learning is acquiring new knowledge, skills, and values.
- Learning is a process that leads to change, which occurs as a result of experience and increases the potential for improved performance and future learning (Ambrose S.A., Bridges M. W, DiPietro M. and Lovett M.C., 2010).
- Learning is a complex interaction of myriad influences including genes, neurophysiology, physical state, social experiences and psychological factors (Stewart Hase and Chris Kenyon)
- As we learn, our view of the world keeps changing.



Now coming to the learning, learning can be defined from several standpoints. First thing is learning is acquiring some new knowledge, skills and values which we did not have prior to learning. If learning did not make any difference to any of these areas that means the learning has not taken place. So learning is acquiring new knowledge, skills and values that we did not have prior to the event of learning.

Then another way of looking at learning is, learning is a process that leads to change which occurs as a result of experience and increases the potential for improved performance and future learning. So, what we are saying is learning is a process that leads to some change. And another way of putting it is, learning is a complex interaction of myriad influences including genes, neurophysiology, physical state, social experience and psychological factors.

As these factors are different for different individuals so what may happen is learning is not exactly the same for all the learners in a particular during an organized learning experience. And what happens, as we keep learning our view of the world keeps changing because we are anything new that we acquire is built on top of what we already know. And sometimes whatever we learned can make a difference to us, sometimes may not make a difference to us. So but still in the net our view of the world keeps changing as we learn.

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Learning (2)

- Possession of information is not synonymous with learning.
- Learning is stabilizing, through repeated use, certain appropriate and desirable synapses in the brain (Leamson R, Biologist, 1999).
- Learning imposes new patterns or organization on the brain, and this phenomenon has been confirmed by electrophysiological recordings of the activity of nerve cells.
(National Research Council, 1999).



Now, possession of information is not synonymous with learning. That means merely if you accumulate information that is not synonymous with learning at all. Possession of information you may reproduce it but that may not translate into acquisition of new knowledge. So possession of mere information is not synonymous with learning. A little bit of neuroscience point of view, learning is stabilizing through repeated use certain appropriate and desirable synapses in the brain. So after all learning takes place in the brain.

So physiologically what happens is, certain synapses because of repeated use they get stabilized, they become somewhat semi-permanent. So learning can be interpreted in terms of stabilizing the desirable synapses. You may also stabilize some undesirable synapses which leads to acquiring some bad habits. Now another way of looking at again from neuroscience, learning imposes new patterns or organization in the brain and this phenomenon has been confirmed by electrophysiological recordings of the activity of nerve cells.

So, what was observed is as you keep learning, new patterns of organization in the brain are observed through available experimental methods.

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Learning Theories

Behaviorism (J.Watson)

- Learning is the acquisition of a new behavior through conditioning.

Cognitivism (Jean Piaget)

- Humans learn by generating knowledge and meaning through sequential development of their cognitive abilities including recognition, recollection, understanding, application, reflection, analysis, evaluation and creation.



Now there are a whole bunch of learning theories and still newer theories are coming into vogue. The oldest one that we know of is the “behaviorism”. It is based on saying that we do not know what exactly is happening inside the brain. That is because this particular viewpoint came into being during early part of the 20th century. And here the school of behaviorism stated learning is the acquisition of new behavior through conditioning.

That means people are given some stimuli and they respond in some way by conditioning we can make people to respond in a desirable way. So that is what the behaviorism is. There has been enormous amount of criticism of this over the decades but still there are many practices that have

come from behaviorism which are still in use during both elementary to university type of education.

Then another theory is “cognitivism”, where around 1940s there is a some amount of understanding what is happening in the brain. Based on that it was it was felt humans learn by generating knowledge and meaning through sequential development of their cognitive abilities. We will be spending more time on this cognitive abilities and these include recognition, recollection, understanding, application, reflection, analysis, evaluation and creation.

These are all the cognitive activities a human can perform. So to that extent our learning can be looked through this cognitive activities.

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Learning Theories (2)

Social Constructivism (John Dewey 1933, Bruner 1990, Piaget 1972 and Vygotsky 1978)

- Considers that learning occurs within a context that is itself part of what is learned, knowing and doing cannot be separated, and learning is a process that is extended over time.
- Discovery, hands-on, experiential, collaborative, project-based, and task-based learning are based on constructivism.



Then came what we call “social constructivism”. First constructivism is what it believes is as we keep learning our view of the world keeps changing. So we are continuously reconstructing our view of the world. And then social constructivism says that, we can do that through social interactions much better. And there is enormous amount of research that is done and some schools follow strictly their entire school learning through social constructivism.

Techniques like discovery learning, hands-on learning, experiential, collaborative, project based, task based learning are all based on this theory of constructivism.

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Learning Theories (3)

Heutagogy (Stewart Hase, 2000)

- Heutagogy is the study of self-determined learning. Heutagogy, a form of self-determined learning, is a holistic, learner centered approach to learning and teaching, in formal and informal situations.
- Knowing how to learn will be a fundamental skill given the pace of innovation and the changing structure of communities and workplaces.

Paragogy (J. P. Schmidt, 2009)

- Paragogy deals with analysing and co-creating the educational environment as a whole by the peers, who share their learning situations and experiences benefiting from information technology.

Now, relatively recent one it is called “Heutagogy”, is the study of self-determined learning. What it means is, it is a form of self-determined learning that is holistic learner centered approach to learning and teaching in formal and informal situations. Now this can be technically absorbed under social constructivism but here it highlights this. That means knowing how to learn is a more important skill than just acquiring knowledge.

And this is where what do you call this also gets reflected in one of the program outcomes that we are going to look at namely the what do you call a graduate of engineering program should know how to learn by himself. Because of the constant change in the structure of our communities, work places, technologies you cannot remain static and you have to constantly learn on the fly.

And that is how heutagogy becomes a dominant is considered important in present era. Similarly, “paragogy” is also can be considered as a part of social constructivism. But again it highlights as paragogy deals with analyzing and co-creating the educational environment as a whole by the peers who share their learning situations and experiences benefitting from information technology.

That is you learn better through social interactions and one should actually plan the learning situations like that and the role of information technology is that the peers need not be always face to face. They can interact with each other over the internet.

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Learning Theories (4)

Connectivism (George Siemens, 2005)

- Connectivism is the integration of principles explored by chaos, network, and complexity and self-organization theories.
- Learning is a process that occurs within nebulous environments of shifting core elements – not entirely under the control of the individual. Learning can reside outside of ourselves (within an organization or a database). It focuses on connecting specialized information sets, and the connections that enable us to learn more.

Then another learning theory is “connectivism”. This is still the result of today’s growth in the information technology. Connectivism is the integration of principles explored by chaos, network and complexity and self-organization theories. We consider the knowledge exist in a diffused way in a nebulous environments.

So what happens as you keep exploring. for example as a learner, you yourself can explore what is this concept of connectivism and how it is going to be useful to you with respect to your subject. When you explore, there is a tremendous amount of knowledge that is available in various notes that means various websites that you will have. Depending on how you keep traversing that, your learning will differ.

So your connectivism to that extent is a means of or means of learning which you can consider nonlinear and it cannot be exactly decided in advance this is the way you have to learn like reading a given textbook. So these are some of the learning theories. There can be, one can maybe list some more but these are the present day dominant learning theories.

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Principles of Learning Process

- Educational psychologists derive principles of learning process

Principles of Learning: some examples

- Contiguity
- Repetition
- Reinforcement
- Socio-cultural context of learning:
Negotiated meaning, situated cognition, activity theory etc.

Now educational psychologists derive principles of learning process and some of the principles of learning, some examples are “contiguity”. That is how two topics are related to each other. So one topic becomes a prerequisite to the next one which is a fairly simple thing to understand. And another one is “repetition”. As we know through repetition we can understand or learn better. That is practicing some problems you keep on repeating, repeatedly you read something and similarly “reinforcement”. Your understanding of a concept can be reinforced by a large number of examples. You should be able to relate to that. And similarly if you look at “sociocultural context of learning”. That means learning depends on the context in which you are learning. Okay this is where issues like negotiated meanings, situated cognition, activity theory etc. start becoming relevant.

We are not going to explore these things but all that we need to realize is there are several principles of learning that have been identified over the years.

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Assessment

- Assessment is a measure of performance
- Evaluation is an interpretation of assessment
- Our assessment tools tell students what we consider to be important
- Teachers guide students to learn through their assessments
- It is a glue that links the components of a course - its content, instructional methods, and skills development
- Assessment drives student learning

Now come to the another topic “assessment”. What is assessment? Assessment is a measure of performance. For example, how do I know a learner has learned something? So as a consequence of learning, he has to perform. This performance could be like solving a problem or making a presentation or performing an experiment in the laboratory, it can be, there are many such activities which can be used to measure to what extent a student has learnt.

And what happens once somebody perform something like performs an experiment then evaluation is interpretation of assessment. That means once the instructor observes to in what way the student has performed the experiment and got the results he will give a mark or a grade to that. That giving a mark or a grade is considered evaluation.

Unfortunately, even in the teaching community, the word assessment and evaluations many times are these words are interchanged. So there should be a clear difference between assessment and evaluation. Now what happens students how do they prepare, how do they plan their learning because at the beginning of any semester, a student really wants to do well in the examination. He wants to get a good grade. And how does he get a good grade?

It depends on how well he has performed in various tests that have been designed. It could be class test, it could be assignments, it could be laboratory or it could be the end semester examination. So what happens, he has to find out or the teacher has to tell him what kind of

assessment tools towards which they have to prepare themselves. So essentially you are telling through your assessments what is considered important. Because after all the student will spend time on what is considered important.

So putting it in another way, teachers can guide students to learn through their assessment by working out a problem in the class or making them work out a problem in the class or giving the right kind of questions in the end semester exams you are able to guide the students to learn well.

So if you, your assessment is poor, automatically the students will, the learning by the students will also be poor. So in a way assessment is a glue that links the components of a course, that is its content, instructional methods and skills and development, okay? So in summary you can say assessment really drives student learning. So to that extent assessment is really central to learning.

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Types of Assessment

- Formative Assessment (Assessment for Learning or Educative Assessment)
- Summative Assessment (Assessment of Learning)



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Now, what are the types of assessment that you have? A formative assessment and summative assessment. Formative assessment means you are using assessment as a means of facilitating learning like for example you are asking a question in the classroom or you conduct a quiz for which you are not giving any marks but it essentially serves as a feedback both to the teacher as well as the student.

And that is what we call as formative assessment or it is also considered assessment of learning or educative assessment in the sense that no marks are given. Whereas summative assessment is, you are assessing to determine to what is it that the student has learnt either up to a point or at the end of a course. So that is where you are actually grading or marking the student's performance.

Some purists believe there should never be summative assessment, there should only be formative assessment. That is the best way to learn. But unfortunately what happens formative assessment once the student knows that it is not going to make a difference whether he performs or not in that he may or may not put the required effort to perform. He may be capable but he will not put the effort and this also has been observed universally, so, to that extent formative assessment while it is certainly desirable we cannot completely depend on that.

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Alignment

- Assessment should be in alignment with stated outcomes of education

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Now, another important feature of assessment is the “alignment”. Assessment should be in alignment with stated outcomes of education. Your stated outcomes which we will see in great detail in the later units, if the outcome for example considers the student should be able to solve certain problems let us say in electronics. That means he should be able to design a circuit to perform a certain function. That is the goal.

But in actual assessment you only ask the theory of a device or describe a circuit or find out what is the function of the circuit. If your assessment is only limited to that, that means your

assessment is not in alignment with the stated outcome. This is one of the very important properties and unfortunately today if you look at majority of the test papers or the university exams, there is a total lack of alignment between the assessment and at least perceived outcomes of the course.

So a systematic effort should be made in designing your test papers to ensure there is adequate alignment between assessment and the stated outcomes. We will be seeing more of this in later units.

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Instruction

- Purpose of instruction is to help people learn and develop
Learning and development can be
 - cognitive
 - affective
 - psychomotor
 - Spiritual
- Learning can certainly occur without instruction
- Instructional designers apply the principles of learning to the design of external events we call instruction.

Now come to the third topic namely “instruction”. Purpose of instruction is to help people learn and develop. And learning and development as we will see in later units can be looked at 4 levels. It is a cognitive level, affective, it is not really, domains of learning you can say cognitive domain, affective domain, psychomotor domain and spiritual domain.

While all the all of them are important to varying degrees in different situations, especially while affective domain is very important but as of now we really do not know how to integrate the learning in the affective domain with the cognitive domain. So at present the learning is dominantly is kept at cognitive domain and some courses, some type of topics, psychomotor domain may also become important.

Like courses on theater, drama or paintings, music, sports and so on, psychomotor domain becomes important. And what should be realized is learning can certainly occur without instruction. Nobody need to hold out hand. Just if you live your life possibly you are constantly interacting with the outside world and you are leaning. But if you want a student to or learner to acquire some outcomes then the instruction becomes important.

Now instructional designers apply the principles of learning to the design of external events we call instruction. So instead of leaving it to chance occurrence, instructional designer who a teacher also with a little bit of knowledge can become a instructional designer. He plans external events. What type of events are we talking about?

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Principles of Instructional Design

Would help

- Instructors to decide
 - when practice and feedback will be most effective,
 - when it would benefit students to be put into groups,
 - the pre-requisites for problem-solving and higher-order learning skills
- Producers of instructional materials
- Curriculum material developers
- Web-based course designers
- Knowledge management system designers



The events could be like demonstrating some new knowledge or conducting a quiz or asking the students to discuss with each other. Or asking individual student to solve a problem in the class. These are all instructional events and an instructional designer or the teacher will organize these events in a proper sequence. That is what instructional design is. And we need some principles of instructional design. What would they do?

This if you understand the principles of instructional design, they would help instructor to decide when practice and feedback will be most effective. That means at what point of interaction in the classroom or otherwise you have to make student to practice something and when do you take

the feedback? You have to choose the right kind of movement for it to be most effective. And when do you actually want to work students in groups?

Some exercises are best done in groups. Some are not suitable for group activity. So an instructor will have to decide when actually when is it beneficial to put students into groups. For example what we call we will again elaborate problem solving higher-order learning skills. How do you take the student through various phases so that he is going to acquire the higher-order learning skills and what are the prerequisites and how do you sequence them.

And these principles of instructional design would also help producers of instructional materials. Instructional materials are what an instructor uses. Curriculum material developers, that is the material that is going to be used by the learners and web-based course designers, knowledge management system designers, these principles of instructional design would be beneficial to all of them.

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Instructional Design Theory

- It is a theory that offers explicit guidance on how to better help people learn and develop
- It is a design-oriented theory
- Identifies methods of instruction (ways to support and facilitate learning) and the situations in which those methods should and should not be used
- Methods are probabilistic rather than deterministic

And what is instructional design theory? It is a theory that offers explicit guidance and how to better help people learn and develop. So there are several design theories as we see. They offer explicit guidance and how to better help people to learn and develop. It is a design oriented theory. We will presently see what a design oriented theory is and these theories will also identify

methods of instruction and the situations in which those methods should and should not be used. Every type of instructional method should not be used in all conditions.

So an instructional design theory will also kind of help you in choosing the right kind of situation for applying a method. One thing should be remembered, any method that is suggested is only probabilistic rather than deterministic because learning as we noted is a function of a large number of factors. It is impossible and each student is different from the other. What works for one person will not work for another person.

But so to that extent any methods that you suggest we can only say the probability of the student learning better improves if you follow this instructional method. So everything is probabilistic.

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Design Theories

- are prescriptive in nature, in the sense that they offer guidelines as to what methods to use to best attain a given goal.
- are intended to provide direct guidance to practitioners about what methods to use to attain different goals
- their major concern is preferability

And what are “design theories”? Design theories are different from what we call descriptive theories. Most of the research that we do in any particular discipline is dominantly descriptive theory. Descriptive theory means a cause A leads to effect B. You may hypothesize and then either experimentally or theoretically you prove or disprove A leads to B or not and much of the research is done like that.

Whereas design theory is prescriptive in nature. So what happens, prescriptive means if you do like this you will reach your goal better. That is what we mean by a prescriptive thing. So to that

extent all instruction design theories are design theories in nature and they are intended to provide direct guidance to practitioners about what methods to use to attain different goals. But results are not guaranteed. So when do you consider a design theory is good? That if one theory leads to better achievement of goals when compared to another theory, then we consider it is a better designed theory. So you consider the measure is preferability. That means one particular theory is preferred over the other. That is the nature of design theories.

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Theory One (Perkins 1992)

Clear information: Descriptions and examples of goals, knowledge needed, and the performances expected.

Thoughtful practice: Opportunity for learners to engage actively and reflectively whatever is to be learned.

Informative feedback: Clear, thorough counsel to learners about their performance, helping them to proceed more effectively.

Strong intrinsic and extrinsic motivation: Activities that are amply rewarded, either because they are very interesting and engaging in themselves, or because they feed into other achievements that concern the learner

Now, this is one example of design theory. What it says, it may look pretty obvious but stated in a, in clear steps. Clear information should be provided to the student. That is descriptions and examples of goals, knowledge needed and the performances expected. Thoughtful practice, opportunities for learners to engage actively and reflectively whatever is to be learned.

This is very important. Unfortunately in our current practices we do not give adequate opportunity for learners to engage actively and reflectively. We focus more on information transmission or information transfer and leave the learner's engagement to either chance or you expect them to do on their own. It is not a guided activity. And the moment you bring that into the classroom, it is going to take considerable effort, considerable time for that.

So thoughtful practice how to integrate into the regular classroom work is a major challenge. And then third point is informative feedback. Clear, thorough counsel to learners about their

performance helping them to proceed more effectively. That means constant feedback has to be given. Once again it is a challenge. You cannot give this feedback to each and every individual separately.

So you have to work out a method of giving feedback to the maximum number of people. For example, tutorials do help in this process. Strong intrinsic and extrinsic motivation. That means activities that are amply rewarded, either because they are very interesting and engaging in themselves or because they feed into other achievements that concern the learner. What it means is, all activities that we plan should somehow be of interest to the learner.

Either he considers, yes it is a bit challenging. The learner likes to work on such a thing. Or he thinks that solving this problem or learning something will lead to achievement of things that he is truly interested. So and both of them, both intrinsic and extrinsic motivations will have to be arranged for the student. A trivial thing is you can say those who solve the problem first in the class can be rewarded by let us say you give a small reward. That itself can sometimes can be motivating to students.

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Some more theories of ID

- Direct Approach
- Discussion Approach
- Experiential Approach
- Problem-Based Approach
- Simulation Approach

Some more theories of instructional design call it direct approach, discussion approach, experiential approach, problem-based approach, simulation approach. These are all theories of instructional design. Some of them we will be looking at during the module on instruction.

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Assignments

- Which one of the learning theories you can relate to more in your experiences and why? (maximum 250 words)
- Why do we need to be concerned with assessment in engineering education and how? (maximum 250 words)
- Give two examples of your approaches to instruction you felt led to better learning by students in the courses you taught or experienced. (Write maximum 500 words for each example giving some evidence of better learning)

Now coming to the end of this unit, we have looked at three familiar words. We have been using these words for quite some time namely the learning, assessment, and instruction. We tried to give very specific meaning to these words and now coming to the assignments, you write a small note which one of the learning theories you can relate to more in your experiences and why? A maximum of 250 words can be written.

And second one is why do we need to be concerned with assessment in engineering education and how? How do you in what way if you are concerned about the assessment, how are you going to where is it going to reflect, what are the planning to do. Once again, write a few maybe build up points maximum 250 words. Give two examples of your approaches to instruction you felt led to better learning by students in the courses you taught or experienced.

So take two examples from your own course which you have taught several times and try to take an example from that you thought by following that the students have learned better. Write maximum 500 words for each example giving some evidence of better learning. It is not your view alone, but some evidence will have to be given on basis on which you learn you thought the students have learnt better.

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MIU4

- Understand the features of Outcomes and Outcome Based Education that make education student centric.



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Now when we go to the next unit, we attempt to now understand the features of outcomes and outcome based education that make the education student centric. As we said right in the first unit, the major shift that is taking place is making the education student centric. So we try to establish through the next maybe two units that outcome based education truly makes the education student centric. Thank you.