Teaching and Learning in Engineering (TALE)
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Lecture - 09
Taxonomy of Learning

Greetings and welcome to the Module 1 Unit 9. The unit is concerned with the Taxonomy of Learning.

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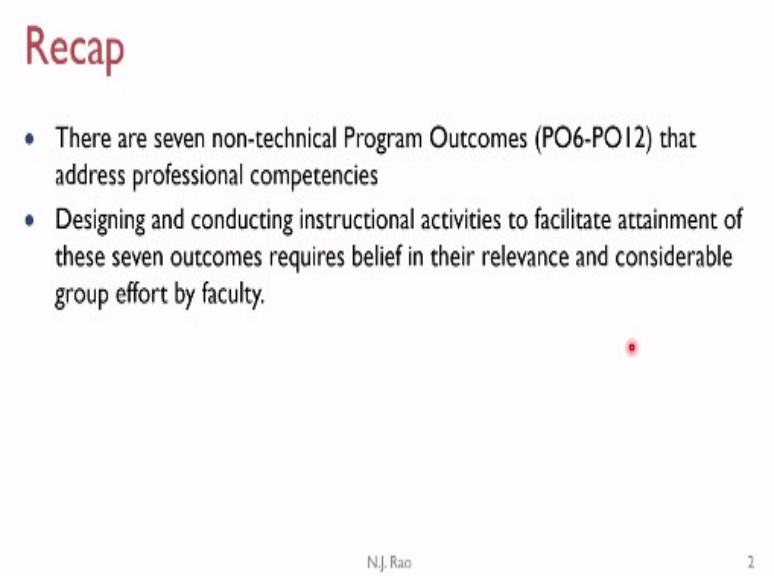

We looked at in the previous Unit 8, the seven non-technical Program Outcomes. They addressed the Professional Competencies. And designing and conducting instructional activities to facilitate attainment of these seven outcomes first requires belief in their relevance and considerable group effort by faculty. If you want to do that because if you look around the engineering programs the way they are conducted these seven outcomes are hardly addressed directly.

One can justify some indirect addressing of this but directly PO6 to PO12 are very rarely addressed in the sense they do not get reflected in the assessment that we perform.

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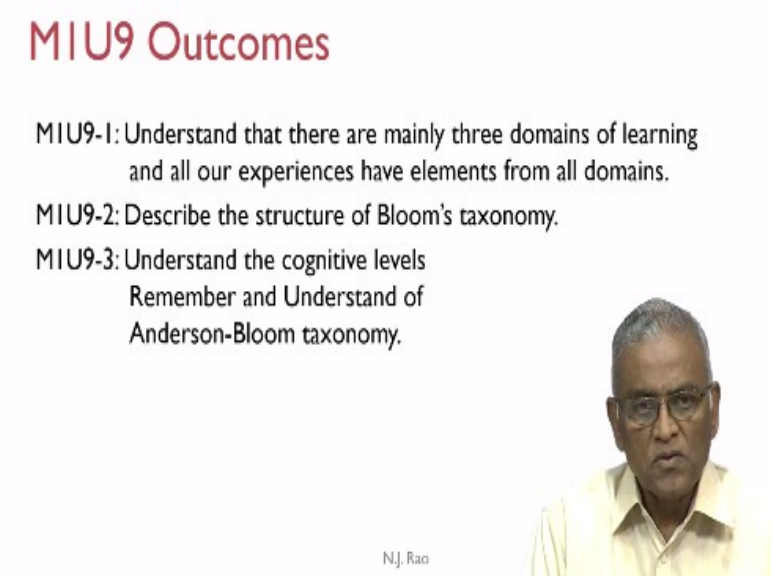

The Module 1 Unit 9 the outcomes are understand that there are mainly three domains of learning and all our experiences have elements from all domains. Then describe the structure of Bloom's taxonomy. And particularly we tried to understand the cognitive levels. Remember and understand of Anderson-Bloom taxonomy. These are the three outcomes that we address in this unit.

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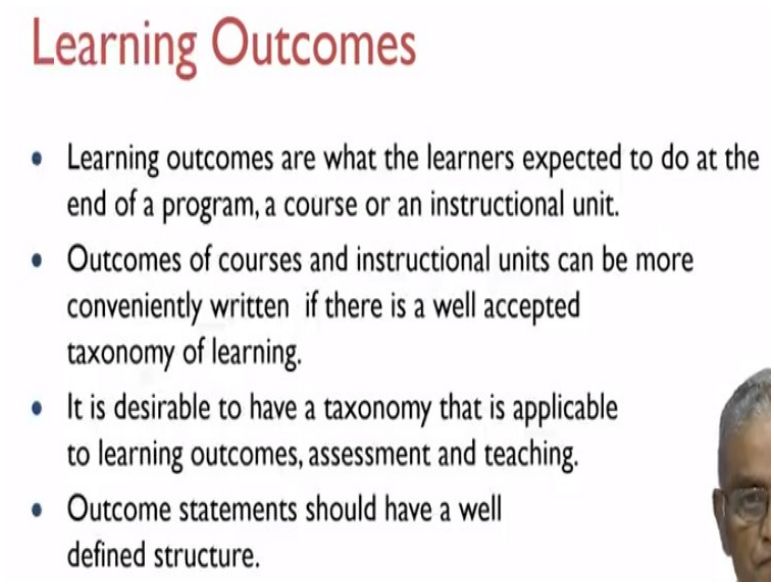

Now, once again we will try to repeat what we have stated about learning outcomes. Learning outcomes are what the learners are expected to do at the end of a program, a course or an instructional unit. Now how do we write the outcomes of courses? We have to state the learning outcomes and then conduct the instruction to attain these outcomes. But how do we classify

outcomes or how do we write these outcomes? We require a kind of a methodology as well as some terminology for communication between the stakeholders.

And when you write outcomes, generally you want a discourse between the two or three faculty members who are concerned with that particular course. That means whenever you are communicating with each other first thing that you have to establish that you have a common language to speak. That means any word that you use it means the same for all. And this is achieved by ageing to work within a one selected taxonomy.

And it is also desirable to have the same taxonomy that is applicable to not only learning outcomes, but also assessment and teaching. That means within the framework provided by one taxonomy we should be able to perform all the activities namely writing outcomes, assessing the student performance and teaching or instruction to facilitate the students to achieve the outcomes. And the outcome statement should have a well-defined structure.

The structure of the outcome statement we will take it up in a later unit after we familiarize ourselves with the taxonomy.

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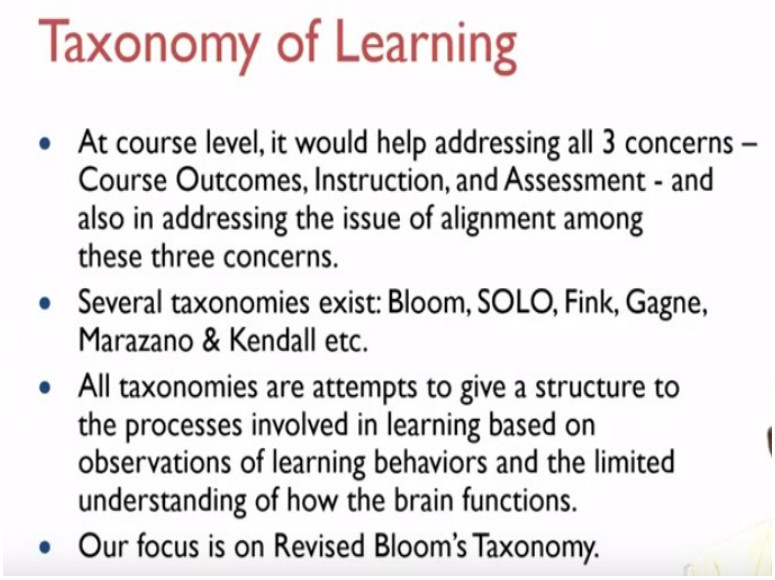

Now, most of the time as a teacher, you are concerned with learning outcomes at the course level. When you want to look at the curriculum design then we are looking at more at the program

outcomes and program specific outcomes and so on. But even at course level, our main concern will be how do I describe my course in terms of course outcomes. But these course outcomes also have to will be addressing a subset of program outcomes and program specific outcomes.

So to that extent course outcomes have to be related to the POs and PSOs. Now when you write course outcomes we are also concerned with the instruction and assessment as well and the issue of alignment between all the three. Because if you write a course outcome for which I cannot easily plan instruction or I cannot easily assess; there is no point in writing a course outcome in that kind of format. Now there are several taxonomies that exist in the literature.

Even many of them are still are practiced. Some of them are Bloom, SOLO, Fink, Gagne, Marazano, and Kendall etc. And all these taxonomies attempts to give a structure to the process involved in learning based on observations of learning behaviors and the limited understanding of how the brain functions. For example we are far from fully understanding how brain functions and how does it process or how does it learn.

First of all, what does learning mean from a brain perspective and how does it process the information? Is there any structure inside the brain? We have a very very limited amount of understanding of how the brain functions and that is the reason why you end up having several taxonomies. Each taxonomy will look at it from a slightly different perspective. Our focus here is on Revised Bloom's Taxonomy which we will presently deal with.

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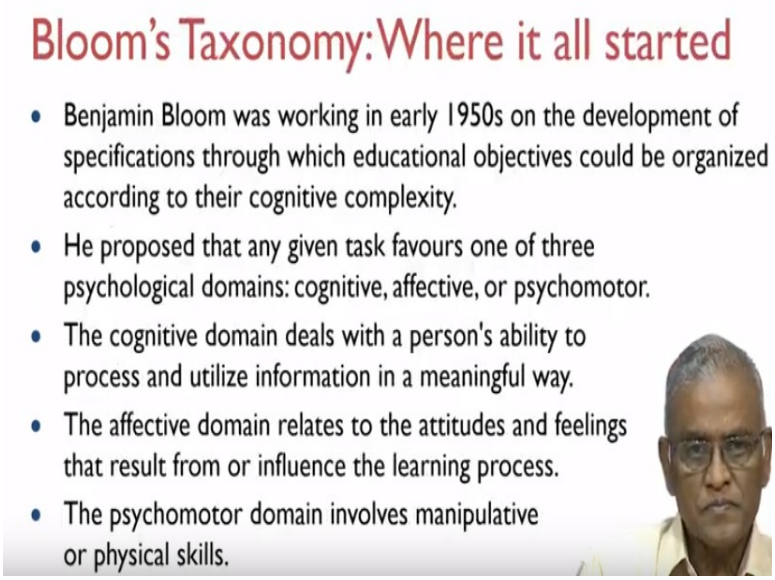

Now a little bit of background on Bloom's taxonomy. Benjamin Bloom was working in early '50s on the development of specifications through which educational objectives, his educational objectives are nothing but learning outcomes, could be organized according to their cognitive complexity. He said wherever you have learning outcomes, of course their main concern was at the school level. Wherever you have these learning outcomes how do I classify them.

For example will all learning outcomes come under the same category? For example I ask one of the outcome is to state some theorem or another outcome could be the student should be able to solve certain class of problems. Obviously solving a problem, remembering something is not at the same level. So to that extent I have to classify these two are two different works. And what he has, first he said as an educational psychologist, there are three aspects.

Namely, there is a cognitive dimension or cognitive domain, there is affective domain, or a psychomotor domain. These are the three psychological domains which were fairly accepted as three domains at that time by disciplines like psychology or social psychology in 19-by 1950s. So first thing he said any given task that you take favors one of the three psychological domains. That means dominantly any experience will be either cognitive, dominantly cognitive, dominantly affective, or psychomotor.

But all the elements of these three domains will be present in any learning experience. And cognitive domain deals with the person's ability to process and utilize information in a meaningful way what we call reference/references to your processing information or what you call we call it intellect. Is a loose word for this but that is what cognitive domain deals with. Processing Information.

The affective domain relates to the attitudes and feelings that result from or influence a learning process. We all know whenever we are trying to learn something, there are always feelings automatically associated with that. The feelings that we get are dependent on our previous background and we relate either positively or negatively to a particular learning experience. So affective domain is always associated with any learning experience.

The psychomotor domain involves with manipulative or physical skills. Certain activities will require some physical skills and in some subjects if you take theater or painting, music; their physical skills really are dominant. You have to master the physical skill, acquire the physical skills to perform those activities. So that is where the Bloom's taxonomy originally started.

And actually the taxonomy was proposed in 1956 and since '56 because this such a large group of educationist, educational psychologist, neuroscientist they are all concerned with that the original Bloom's taxonomy was subjected to tremendous amount of critic. And people did find some reservations about some of the things and there was a committee that in around 2000 year 2000 they sat down and looked at the experiences feedback that was given. And tried to see whether any modifications need to be done.

So they have slightly revised the Bloom's taxonomy first of all by label and slightly reordered the cognitive levels for example. And then came the so called, they proposed also while talking about the cognitive domain, they identified that there are two dimensions to cognitive learning. One is the cognitive process. The second one is knowledge.

You are doing performing some cognitive activity on some knowledge elements. That is what they have identified and they converted cognitive domain into a two-dimensional one, namely cognitive level and knowledge categories.

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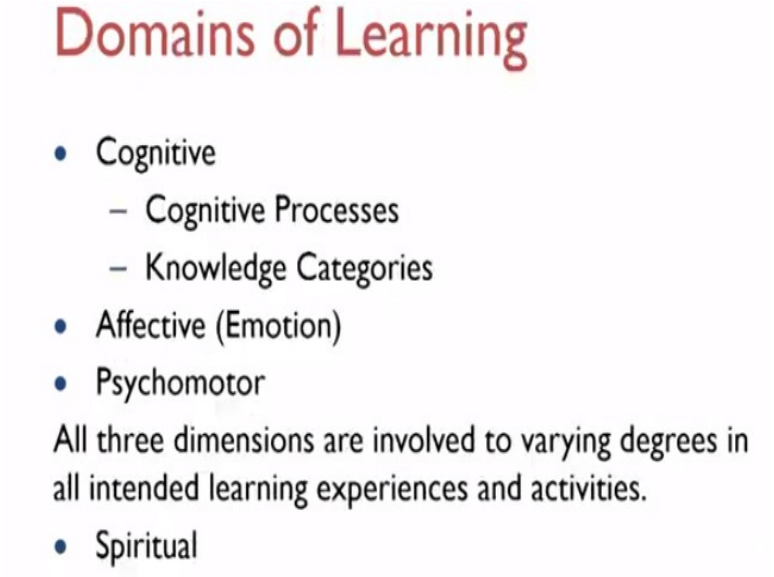

Now this is how the domains of learning can be summarized. You have cognitive which has two dimensions namely cognitive process and knowledge categories. You have affective domain which concerns with the emotion and then third one is psychomotor and all three dimensions are involved to varying degrees in all intended learning experiences and activities. There is no way you can say that one is totally absent.

If one wants to complete this he can also add spiritual domain but in our module we are not going to be dealing with spiritual domain. Just for completion we can add this dimension called spiritual.

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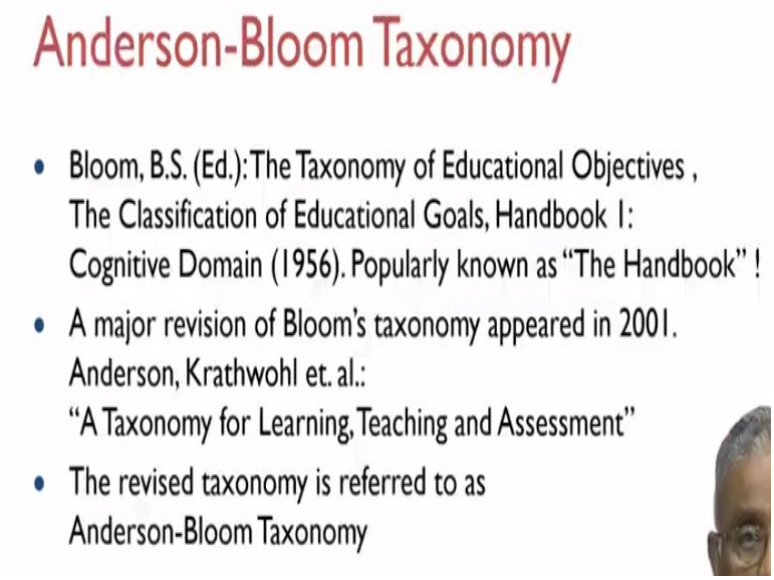

Now the as we mentioned, the original taxonomy, Bloom's taxonomy, Bloom, of course he was a chairman of a committee that came out with but it the last 60, 70 years it goes with the name of as Bloom's taxonomy. And in 1956 that is the book it is popularly known as handbook that was published and then a major revision of this Bloom's taxonomy appeared in 2001. It is presented by Anderson, Krathwohl and several other authors.

The title of the book is A Taxonomy for Learning, Teaching, and Assessment. This I consider a very important book that if you are working within the modified or Anderson Bloom's taxonomy, this is a very very important book to have or access to this book. And this revised taxonomy is now referred to as Anderson-Bloom Taxonomy.

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Now, we can look at the experiences are really integrated. They are not really isolated experience. If you look at these two pictures, you have everything in this. There is cognitive. There is obviously a phenomenal amount of affective, that emotion that is involved and then certainly you have physical skills. So one can say these represent a truly integrated experiences. A dance like that or a performing artist will kind of have these integrated experiences.

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And one can look at dominantly cognitive. That means you somehow pay less and less attention to the other two but you are; these represent kind of a dominantly cognitive experiences.

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You can also consider this as dominantly affective. The main thing that you can see through these pictures is expressing and demonstrating emotion and affection towards each other.

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And then, this is dominantly psychomotor. Here you require extremely high-end skills though (you can say) you cannot say that there is no cognitive dimension to this. There is exactly what to do at what time is a cognitive decision but the dominance is to perform any of these activities you require extreme psychomotor skills. Sometimes you in a given experience you will go through various experiences in a limited period.

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For example, in a 90-minute exam if you have maybe first 85 minutes you are dominantly cognitive but then the last 5 minutes can be quite emotional and go into a bit of affective domain if you are not happy with what you were doing earlier, okay? So you can have change in domains also.

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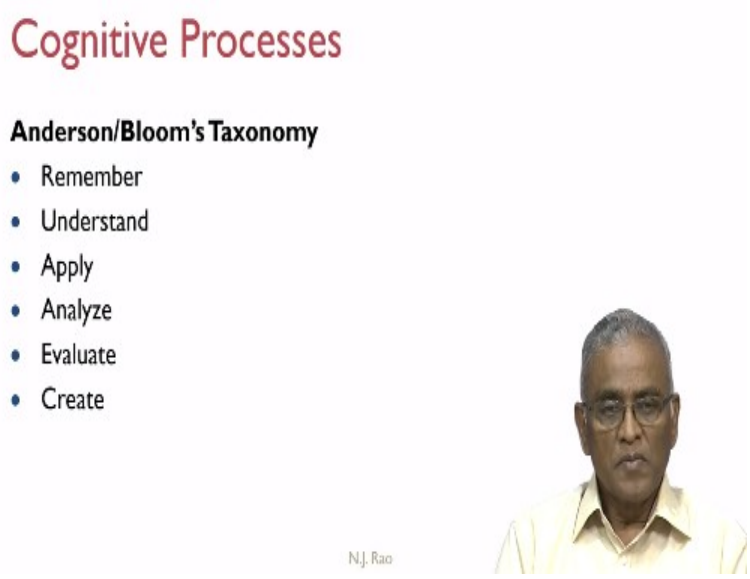

Now, the cognitive processes that we have as proposed by Anderson-Bloom are Remember, Understand, Apply, Analyze, Evaluate, and Create. As you can see these are practically you can say action verbs. They are representative of action because that is the way we require because outcome is stated as, outcome is what the student should be able to do? So here what is he doing? You are remembering, understanding, applying, analyzing, evaluating and creating.

This is what you are doing. So these represent really action verbs. And it is also accepted there is certain kind of hierarchy. Hierarchy in the sense understand activity involves remembering, can involve remembering. Apply activity will involve or likely to involve understand and remember both. Similarly analyze will involve apply, understand and remember and the highest one is create can involve all the other 5 activities.

So there is a kind of a hierarchy that is involved. Hierarchy does not mean higher difficulty levels. We will come to that at a later point. Somehow in the literature higher level activity is considered automatically more difficult which is not true.

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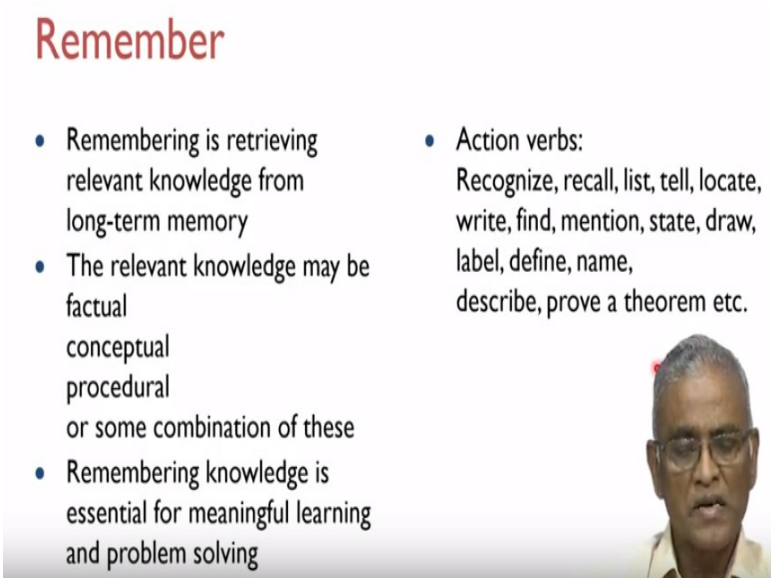

Okay, let us look at remember that is the most what do you call lowest level activity you can say. Remembering is retrieving relevant knowledge from the long-term memory okay? That is you have remembered something or you have put something in the memory and you are required to recall it whenever you want because you cannot each time any time say 2 * 2 = 4, the answer should come from the long-term memory rather than trying to solve it as a mathematical problem.

What is 2 on 2, what is meant by multiplication, what is meant by 2, we are not going through that logic. So what happens for anyone to function, adequately in any area of endeavor, you have

to store lot of information and you should be able to readily retrieve. The relevant knowledge may be factual like what is the density of water? Okay. You do not want to go and consult a handbook, that is a factual information and there should be (conceptual information) conceptual knowledge like what is meant by mass? I am not going to keep going and consulting. I should know that kind of a concept.

Then procedural knowledge. That is how do you calculate. How do you multiply, how do you add. These are procedural knowledge that needs to be remembered. And it can be a combination of any of these. So remembering knowledge is essential for meaningful learning and problem solving. And you have to keep loading lot of information but it cannot stop there.

So this is a lowest level activity and we require to remember many things. Now, how do I associate a verb that signifies remembering? So we use the action verbs to indicate a remember type of activity, recognize, recall, list, tell, locate, write, find, mention, state, draw, label, define, name, describe, or even prove a theorem. These are some of the action verbs that you can use. One may want to add a few more (depending) based on your experience.

But the main thing is you have stored something in the memory and you have to perform an activity that will involve in bringing from a long-term memory to your present conscious state. So that is the activity that is involved in remembering.

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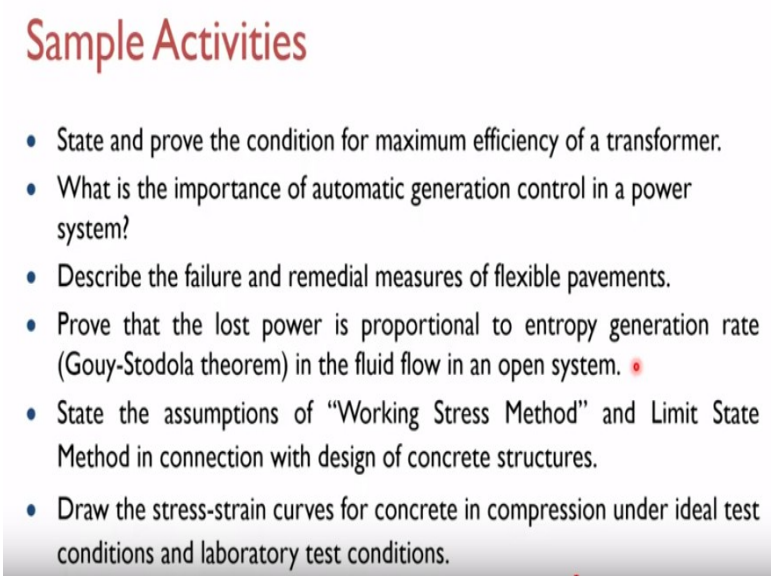

Now some sample activities which we will state in the form of let us say a kind of a problem statement what you can ask in assessment. State and prove the condition for maximum efficiency of a transformer. Okay, one is stating and the second one is proving. Proving the condition for maximum efficiency that there is a method of computing maximum efficiency is presented and you have to prove that. Proof is already given to the student and here you are not calculating.

Please remember that. You are not calculating the efficiency. You are only proving the condition for maximum efficiency. Both are presented to you earlier. You have to recall them and write. So all these examples are (same) similar. What is the importance of automatic generation control in a power system, what is the importance? That is what you are we will see later. You are only stating the importance. It is presented to you earlier, you are remembering.

Describe the failure and remedial measures of flexible pavements. Prove that (low cost) lost power is proportional to entropy generation rate in the fluid flow in an open system. It may sound quite complex and profound but what you are doing is proving that lost power is proportional to entropy is only recalling. State the assumptions of working stress method and limit state method in connection with the design of concrete structures. You are stating the assumptions.

Draw the stress-strain curves for a concrete in compression under ideal test conditions and laboratory test conditions. This is also you are drawing. It has been already shown to you. You are just producing the, reproducing the curves. So these are the sample activities for remember.

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And you can also produce more questions by using these STEMS. What happened after …? And you can fill the gap. How many …? Again, who was it that who stated something …? Can you name the …? Or describe what happened at …. Who spoke to …? What is the meaning of …? What is …? So these are whenever you want to write any assessment items for a particular unit that you are dealing with, learning unit you are dealing with, you can have these as the what do you call starting point for writing your assessment items.

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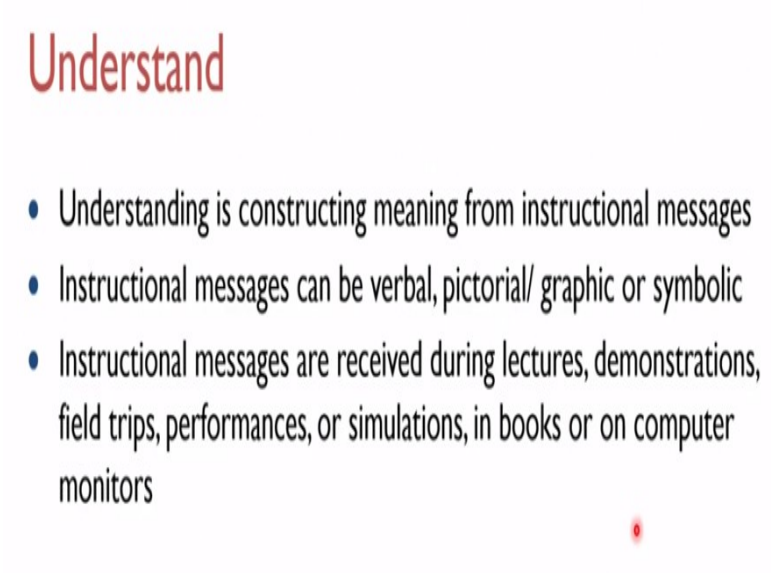

Now come to the major (another) very important slightly more obviously more complex than remember. Understand, now there is also when you look from the old taxonomy or Bloom's taxonomy, the first taxonomy, understand is a word is almost has a derogatory meaning. So people who work with original Bloom's taxonomy, they do not like this word. The word they use is comprehend. But after lot of feedback coming from all over the world, (they) the group decided to come back to the word understand.

Understanding is constructing meaning from instructional messages. The instructional messages can be verbal that is somebody speaking or it can be pictorial or graphic or symbolic in terms of equations. And instructional messages are received during lectures through demonstrations, field trips, performances, or simulations, in books or (in) on computer monitor. So the instructional messages can come from any of these sources.

And I need to construct meaning from these messages. For example at present you are listening to something which is a verbal and possibly you are seeing on a monitor or a cellphone and you have to construct meaning from those instructional messages. That is understanding.

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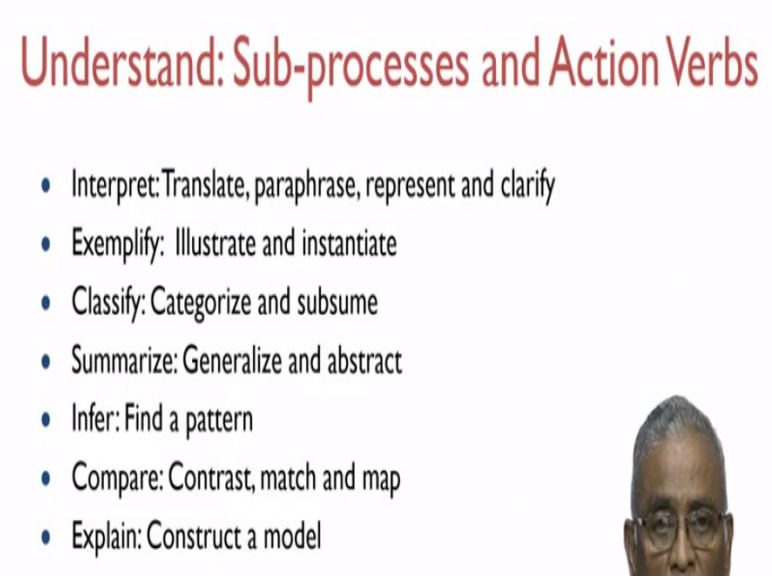

Now understanding has fairly large number of sub-processes involved in understanding. So there are seven that are listed here. Let us quickly go through this. Interpret. Interpretation means translating into your own words or paraphrasing or represent or clarify. For example something is presented to you, you can be asked a question clarify what is being stated in that or translate into in your language or paraphrase in your own words. These are interpretation.

That is what is called the earlier what we are trying is construct a message out of what is presented to you. Now next is Exemplify. That means something is presented to you. You illustrate. Some theorem is presented to you. You give an (illustrate) illustration or instantiate something out of that. Give an example, okay? Exemplification is nothing but giving an example. Classify. Classification is categorization or subsuming one into something else. How do you categorize?

Summarize. Summarization is more like generalization or abstracting. Something may be elaborate or complex is presented to you. You convert let us say verbal description into a mathematical form, that is abstract form, that is one way of summarization. Then you are inferring something. In whatever you are presented you are finding a pattern. You are inferring that the elements of what is presented or related in one particular way or you are comparing.

Contrast, match and map. You are comparing two different knowledge elements and then the purpose is only comparing. What are the advantages and disadvantages of A and B or in what way A differs from B. So that is the type of questions that you would ask. And sometimes you just explain. For example we come across many (many) such questions in our tests and examinations. Construct a model. It could be a verbal model or a mathematical model. In whatever way, you are explaining something. So these are the seven sub-processes that we are involved.

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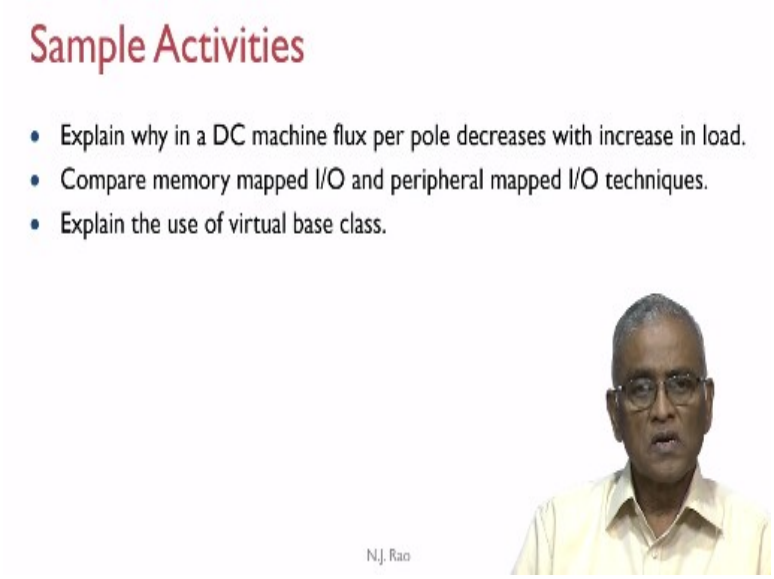

Some sample activities if you look at. Explain why in a DC machine flux (DE machine flux) per pole decreases with increase in load. Compare the memory mapped I/O and peripheral mapped I/O techniques. Explain the use of virtual base class.

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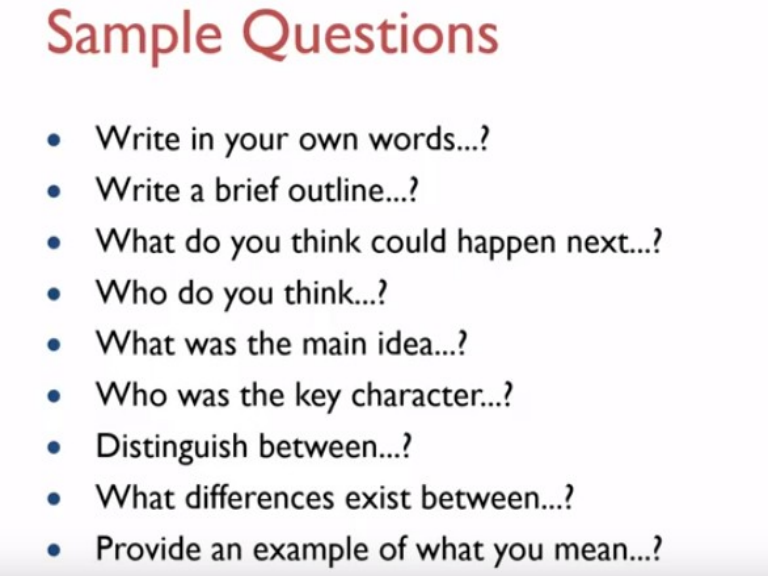

And sample questions as you can see like write in your own words. This is a STEM that you can use and with respect to your subject I am sure you can generate several questions of that type. Write a brief outline …. What do you think would happen next …? What do you think? What was the main idea …? Who was the key character …? Let us say in a given drama or in a literature piece. Distinguish between …. What differences exist between …? Provide an example of what you mean ….

So these are some of the STEMS that you can use in writing questions representing understanding in your assessment.

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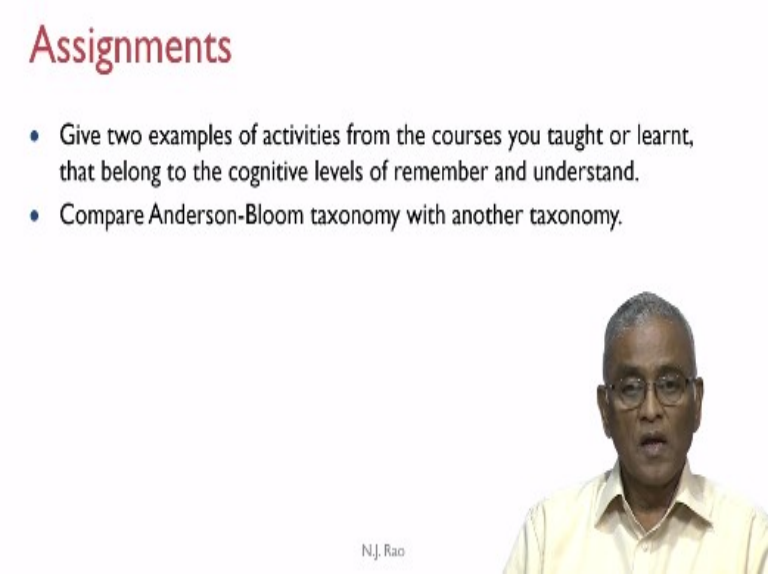

Now, what we would like you to do as assignments, give two examples of activities from the course you taught or learnt that belong to the cognitive levels of Remember and Understand. You are required to give two examples. But they truly should belong to those two categories. Now as an exercise to say that Anderson-Bloom Taxonomy is not unique and other taxonomies are also followed by some people.

But to appreciate that compare Anderson-Bloom Taxonomy with another taxonomy of your selection/choice. Write some kind of a statement to what extent they are common or to what extent they differ and why do they differ?

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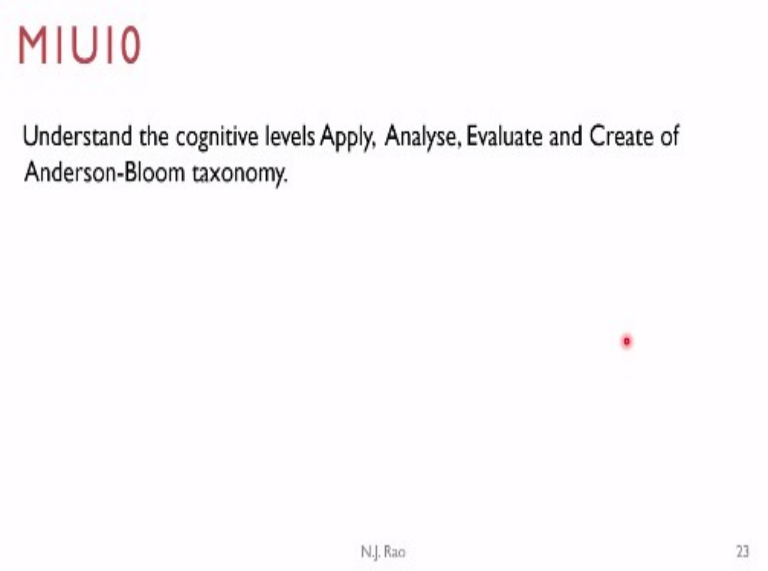

And after this we go into the Unit 10. Mainly the Unit 10 will focus on understanding the cognitive/ remaining four cognitive levels, Apply, Analyze, Evaluate, and Create of Anderson-Bloom Taxonomy. That is the goal of this. Thank you very much for your attention.