NBA Accreditation and
Teaching – Learning in Engineering
(NATE)
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Lecture 12
Cognitive Processes 2

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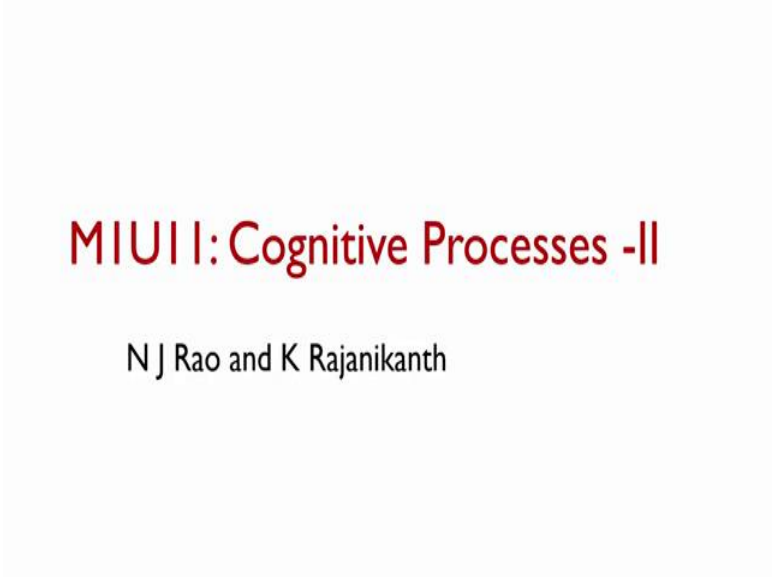

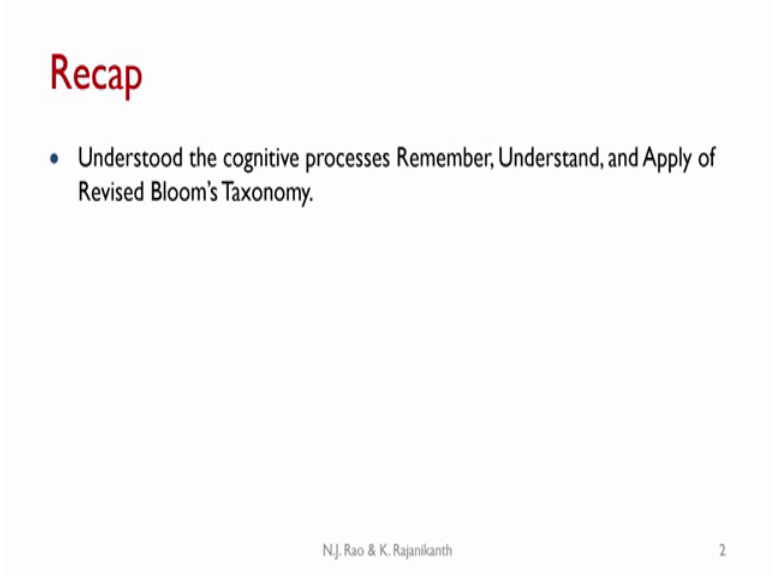

Greetings, welcome to module 1, unit 11 on Cognitive Processes, this is continuation of the previous unit. In the previous unit, we understood the cognitive processes, remember, understand and apply of Revised Blooms Taxonomy.

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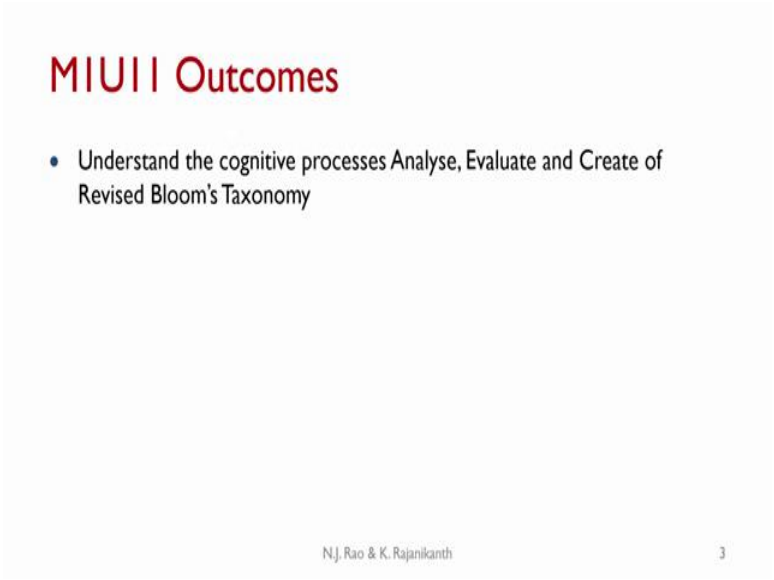

In this unit, we look at the remaining 3 cognitive processes of Revised Bloom's Taxonomy that is analyse, evaluate and create. So, the outcome of this unit is, understand the cognitive processes analyse, evaluate and create of revised blooms taxonomy.

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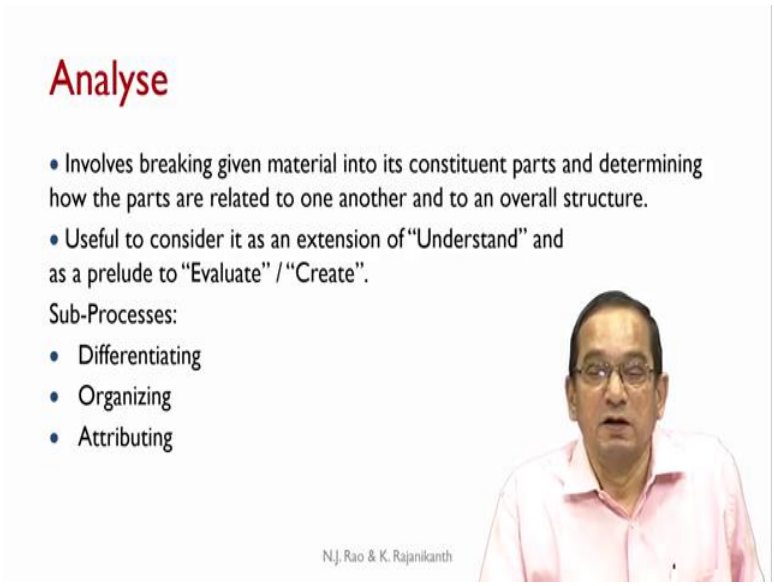

Let us look at the cognitive process analyse. This involves breaking given material into its constituent parts and determining how the parts are related to one another and to an overall structure. It is quite useful to consider this cognitive process as an extension of the understand process and as a prelude to evaluate or create processes of the revised blooms taxonomy.

Analyse primarily looks at a system and then the sub-parts of the system and how they are related to each other in the context of the total system. The sub-processes of analyse are differentiating, organizing, attributing.

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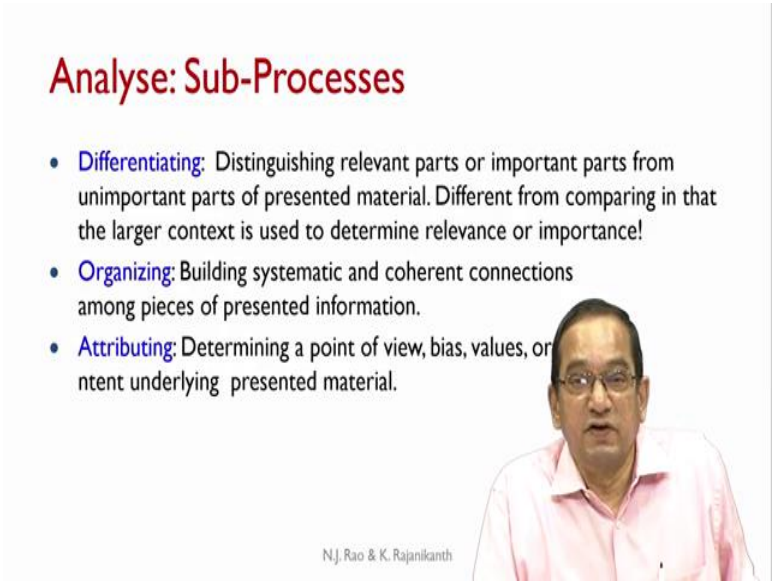

Differentiating, essentially it means distinguishing relevant parts or important parts from unimportant parts of the presented material. Now, how does one determine if a given part is relevant or irrelevant? The analysis phase indicates that the relevance of the part is determined by referring to the total system, the context in which the part is participating. Thus this is different from comparing which occurs at understand level in the sense that the larger context is used to determine relevance or importance.

The relevance or importance of a part or a component or a subsystem is determined by referring to the context in which this part or component or subsystem is occurring. Thus the relevance does not stand by itself, but it is in relation to the system, the context in which the subsystem or the part is participating.

This is the primary difference of analyse activity from the understand cognitive activity. Organizing, building systematic and coherent connections among pieces of presented information. The subsystems or the parts are the sub-processes of the given material are organized. And the systematic and coherent connections among these parts is based on the system in which they are participating.

Attributing, determining a point of view, bias, values of the underlying presented material. Now in engineering courses, attributing is very unlikely to occur, because most of the

engineering courses have an objective view of the material presented. So, the individual bias does not come into the picture in any significant fashion. But in humanities, social sciences, and other areas attributing also may play an important role.

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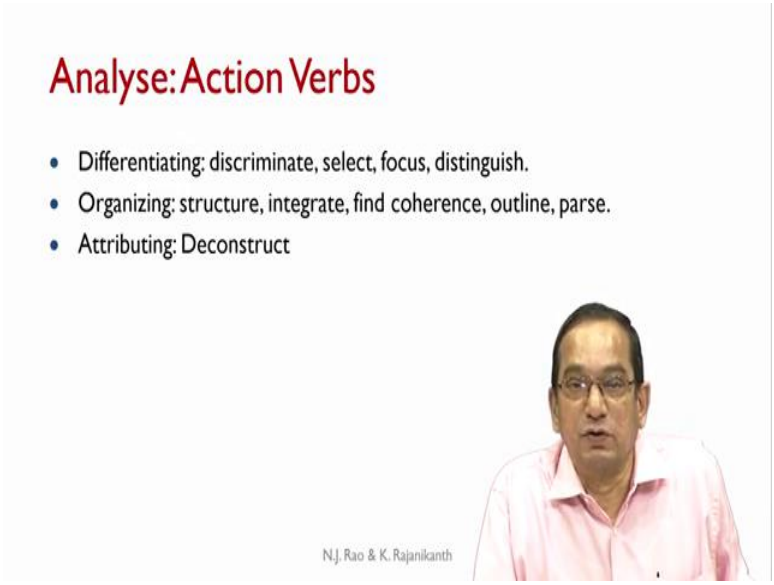

The associated action verbs are for differentiating, discriminate, select, focus, distinguish. Once again, we should notice that the action verb distinguish also occurs with the cognitive level of understand. But, when the cognitive level is understand, distinguish or compare is between 2 entities without reference to any overarching framework.

When distinguish is used in the context of analyse cognitive activity, there is an overall framework, a system, which determines the relevance or importance of some specific property or a component. Thus, distinguish can occur at understand level as well as it analyse level. For the sub-process organizing, the action verbs are structure, integrate, find coherence, outline, parse and so on. For attributing the action verb typically is used deconstruct.

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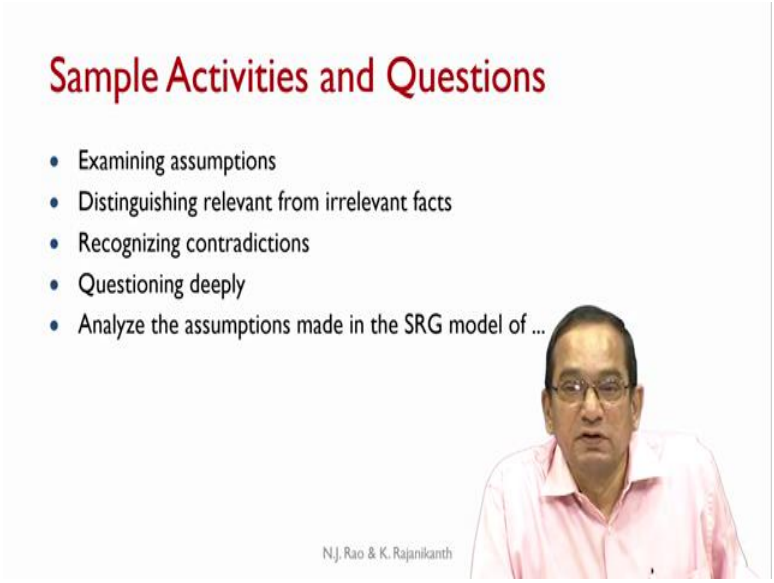

Sample activities and possible questions are examining assumptions, distinguishing relevant from irrelevant facts, recognizing contradictions, questioning deeply, this is more or similar to examining assumptions deeply. An example question can be analyzed the assumptions made in the software reliability growth model of, you can put any name that you want there Goyal or some other model.

So, every model makes certain assumptions and analyzing the assumptions would mean examining the assumptions deeply in the context of the system for which the model is being applied.

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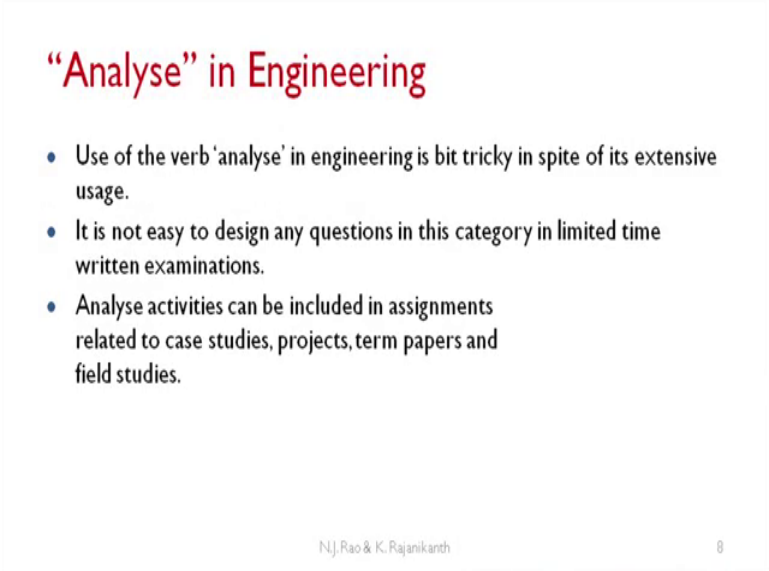

Now, if you look at the cognitive activity of analyse in engineering, we noticed that analyse in engineering is a bit tricky, in spite of its extensive usage. The main reason is that the word analyse as used mostly in engineering courses is apply and thus it is really not analyse activity. For example, when we say analyse the time complexity of the following recursive algorithm, what the student is expected to do is determine the time complexity of the given recursive algorithm using one of the three standard methods.

What the student is actually doing is determining the time complexity according to certain procedure. Thus, this is an activity at the level of apply. However, we are quite accustomed to using the word analyse in such context. In most of the engineering courses, we use the word analyse where the actual intent is apply. However, it is very difficult to get away from that kind of a usage.

But if one is following the revised blooms taxonomy, then analyse has very specific meaning. And one should adhere to that meaning if one wishes to label that activity at the cognitive level of analyse. Most of the analyse activities are actually at the apply level. It is not easy to design questions in this category that can be answered in limited time written examinations. Analyse activities can be included in assignments related to case studies, projects, term papers and field studies.

We have to provide an overall system context and we need the student to answer the questions within the context of the overarching system, then it becomes analyse activity.

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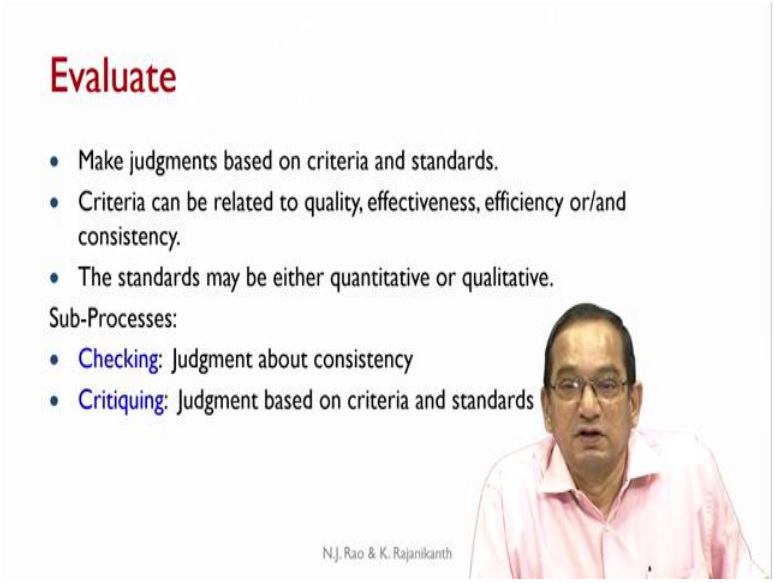

The next higher level cognitive activity is evaluate, make judgments based on criteria and standards. Criteria can be related to quality, effectiveness, efficiency and or consistency. The standards may be either quantitative or qualitative. Quite often, people do make judgments in several different context but the evaluate cognitive process requires that the judgments be based on criteria and standards.

And the sub-processes for the evaluate are checking and critiquing, checking is judgment about consistency essentially that would be the internal consistency of the given material. Critiquing is judgments based on criteria and standards which are generally external.

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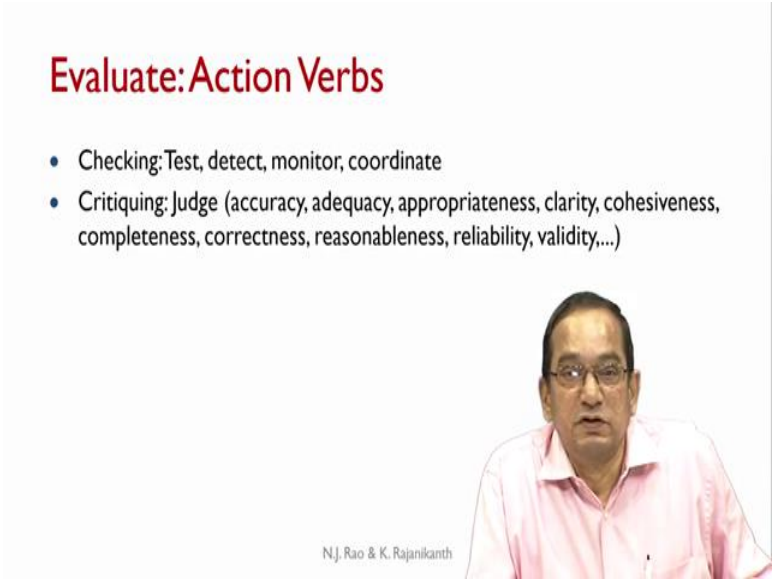

The action verbs associated with evaluate or checking, test, detect, monitor, co-ordinate for critiquing judge, then it can be followed by any of the parameters that are stated here. So, it can be judge accuracy, judge adequacy, appropriateness, clarity, cohesiveness, completeness, correctness, reasonableness, reliability, validity. We can continue with the list.

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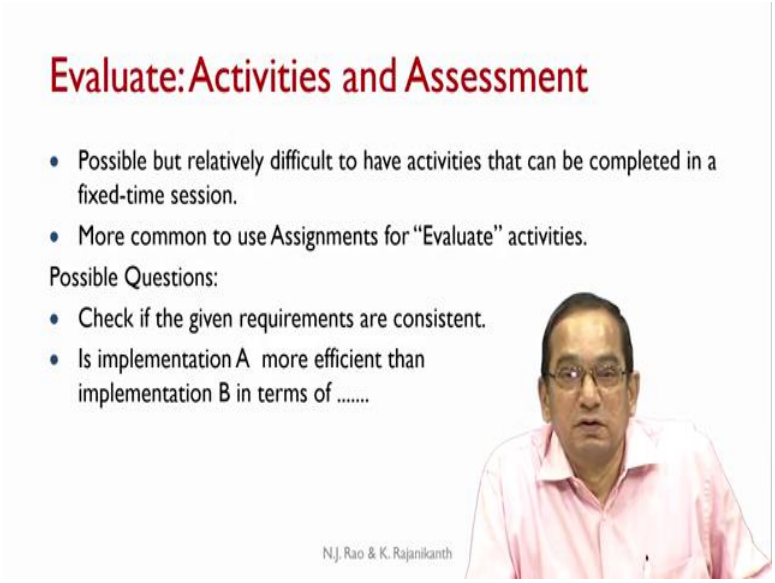

The activities related to the evaluate cognitive processes are again possible but relatively difficult when a fix-time session. Thus usually assignments are the vehicles used for evaluate activities. Some of the possible questions can be check if the given requirements are consistent. That is essentially looking for internal consistency. We could provide the student

with a software requirements specification document and the student can be asked to check if the requirements are consistent internally.

Is implementation A more efficient than implementation B in terms of, here we can add any parameter that is of interest to you. So we could say for example, is implementation A more efficient than implementation B in terms of the total code, source code in print, in terms of the total code size. Or we could say is implementation A more efficient than implementation B in terms of the execution time. So, these are examples of evaluate activities.

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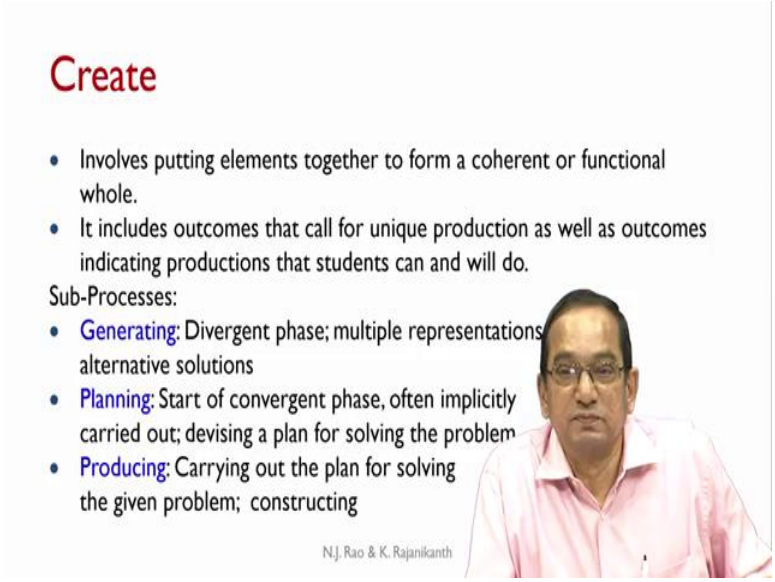

Then the highest level cognitive process which is create. It involves putting elements together to form a coherent or functional whole. When we say, a functional whole, it means that it is a complete system, it is a complete product or it is a complete process. So, it includes outcomes that call for unique production as well as outcomes indicating productions that the students can and will do.

Create normally implies certain uniqueness. However, at undergraduate level, the students may not carry out an activity that leads to truly unique product. But if they can put together the elements to synthesize a functional whole, then that also would be considered as a create activity. Thus create would include outcomes indicating productions that the students can do. Typically, what the students do in final year projects would be at the level of create cognitive process.

The sub-processes are generating, planning and producing. Generating is the divergent phase where the students try to come out with multiple solutions to the given problem, multiple

representations of the problem, alternative solutions to the problem, alternative perspectives to the problem. So, primarily it is a divergent phase.

The next sub-process planning is the start of the convergent phase. Often implicitly carried out here among the alternatives generated in the earlier sub-process, one of the alternatives is picked up as the preferred solution strategy. So, it is devising a plan for solving the problem. It is selection from the alternatives created during the generating phase. So, it is the start of the convergent phase.

The last two sub process is producing where the students carry out the plan for solving the given problem. It is also known as constructing, the solution which has been selected during the planning phase is actually implemented during the producing phase. So, it is also called as constructing.

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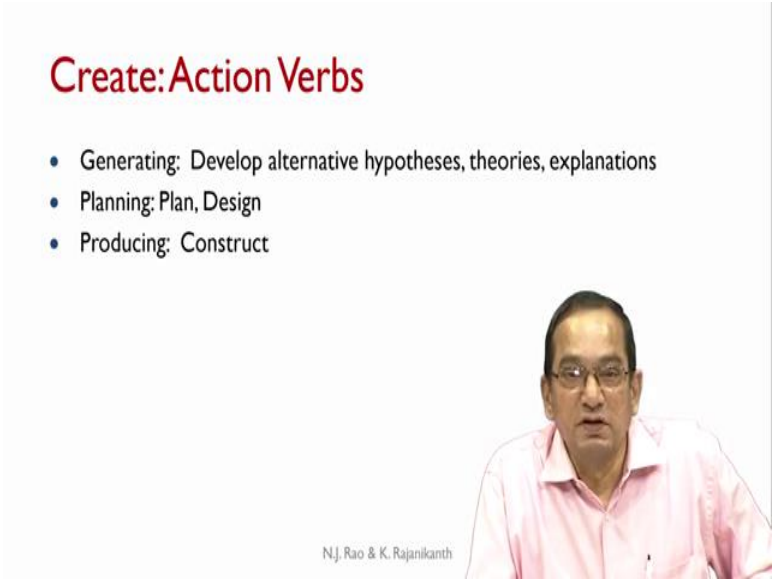

The associated action verbs are for generating, develop alternative hypothesis, theories, explanations. For planning, plan, design. For producing quite often the verb use is construct.

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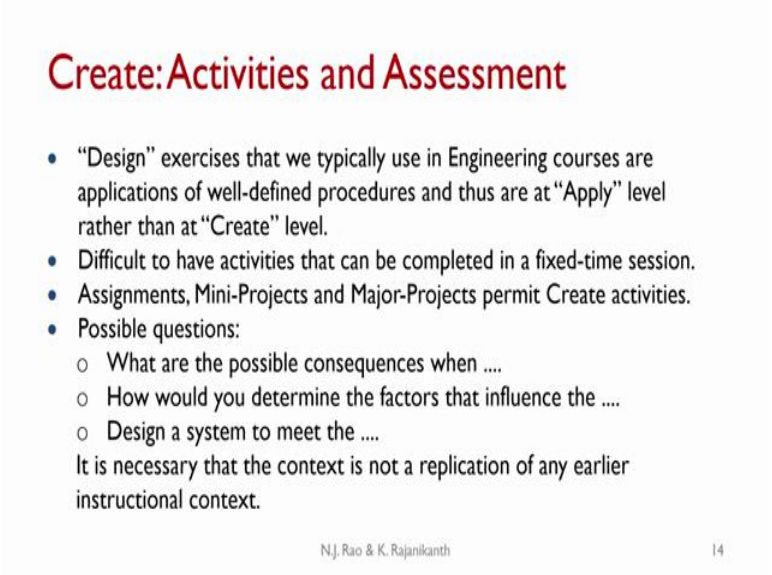

To look at the activities and assessment related to the cognitive process of create, we notice certain anomalies one should be careful of. Design typically would include, would indicate, a create cognitive activity. But design exercises that we typically use in engineering courses are applications of well-defined procedures and thus are at apply level rather than at create level. When we say design a MOD file counter, actually it is application of specific procedure for designing MOD and counters. In that sense, it is not a create activity, but the word is fairly popular in that context.

So, we may continue to use the word design in that context, but when we label that with the cognitive process, we should notice that it is not a create activity. But it is an activity at the cognitive process level of apply. Thus most of the typical design questions that we encounter are at apply level rather than create level. It is very difficult to have activities that will be completed in fixed time sessions, which are at the create level.

Because it requires substantial amount of time and effort on the part of the students to synthesize a total functional system. So, typically assignments, mini projects and major projects permit create activities. And some of the assessment questions could include what are the possible consequences when, now you can give any particular kind of a design choice and ask if that choice is implemented, what are the possible consequences?

How would you determine the factors that influence the? Again you could put any parameter of the system. How would you determine the factors that influence the efficiency of the

transformer? We could put any parameter there. Design a system to meet the, now you write the requirements of the system.

So, these are some of the possible assessment questions that can we have and depending upon the scope of the activity, it can be a mini assignment or a mini project or a major assignment or a major project. It is necessary that the context is not a replication of any earlier instructional context.

Whatever we have discussed in the classroom, whatever activity we have carried out in the classroom, if the same activity is carried out by the student in the assignment, then it is unlikely that the student will get any experience of create level activity. Thus, the student must be made to work in a context that is different from the instructional context.

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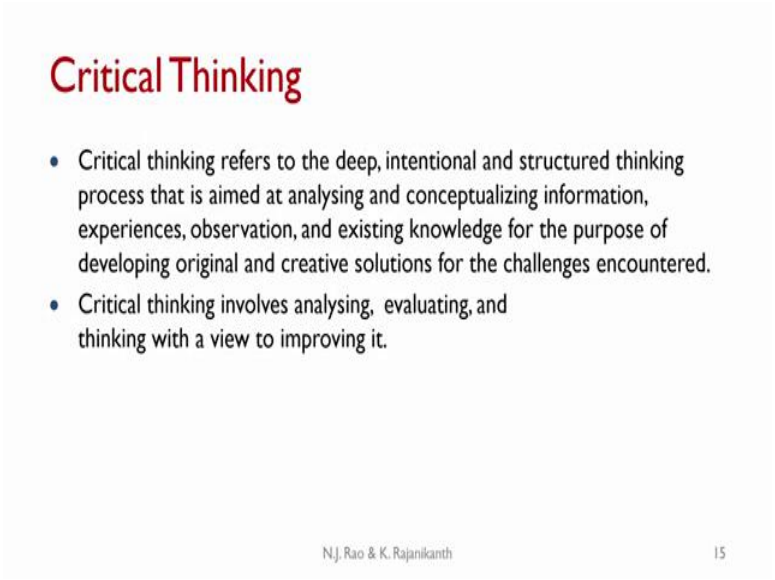

In the last unit, we saw that there are two more words which are very popular in the literature, critical thinking and problem solving. We also saw that neither of this occurs in the revised blooms taxonomy. Let us look at critical thinking. Critical thinking refers to deep, intentional and structured thinking process that is aimed at analyzing and conceptualizing information, experiences, observation and existing knowledge for the purpose of developing original and creative solutions for the challenges encountered.

This critical thinking would involve analyzing, evaluating, and thinking with a view to improving it. It would also involve understanding. Thus, critical thinking is actually a combination of cognitive processes of understand possibly, definitely analyzing, evaluating and thus the revised blooms taxonomy does not give a separate distinct place to critical thinking, but it can be accommodated in the revised blooms taxonomy.

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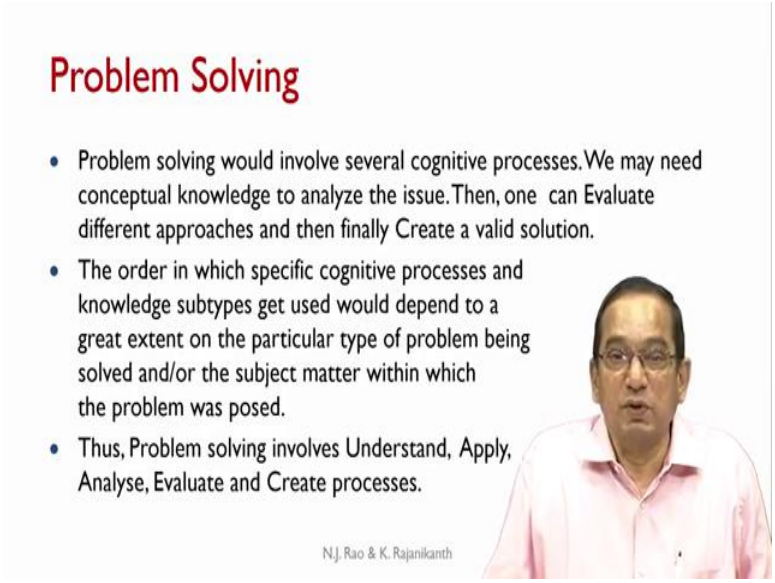

Problem solving would involve several cognitive processes again. We may need conceptual knowledge to analyse the issue. To look at the problem from different perspectives, one can evaluate different approaches and then finally create a valid solution. The order in which specific cognitive processes and knowledge subtypes get used while solving the problem would depend to a great extent on the particular type of problem being solved.

And or the subject matter within which the problem was posed. Thus it is highly problem specific. The specific cognitive processes involved. The order in which they are used would depend on the problem being solved. Problem solving does involves understand, apply, analyse, evaluate and create processes. Again in the Revised Blooms Taxonomy, there is no specific mention of the problem solving activity, because it spans across multiple cognitive processes.

Revised Bloom's Taxonomy can accommodate critical thinking as well as problem solving cognitive activities though they do not occur as distinct, separate cognitive processes. Revised Bloom's Taxonomy can accommodate these cognitive activities also.

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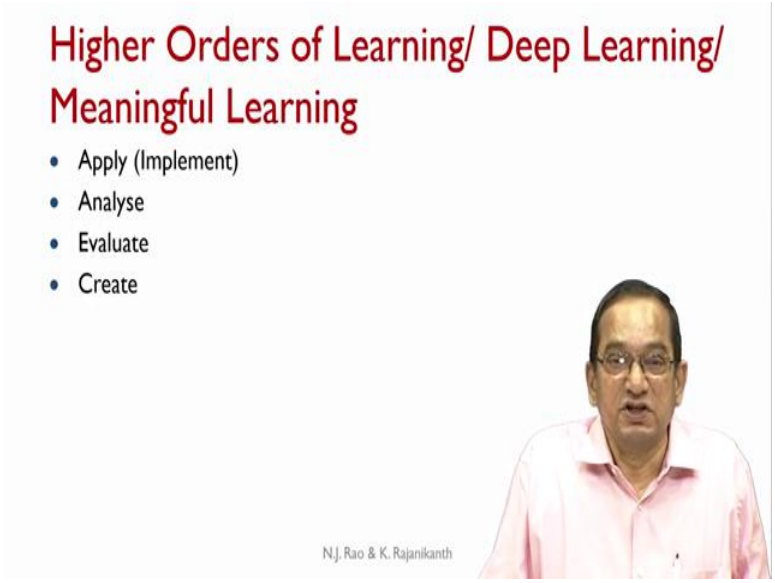

Generally create, evaluate, analyse and the implement of apply are considered as higher orders of learning or the represented deep learning or meaningful learning. And thus to the extent possible, instructors must try to ensure that students carry out learning activities which are at these higher cognitive levels.

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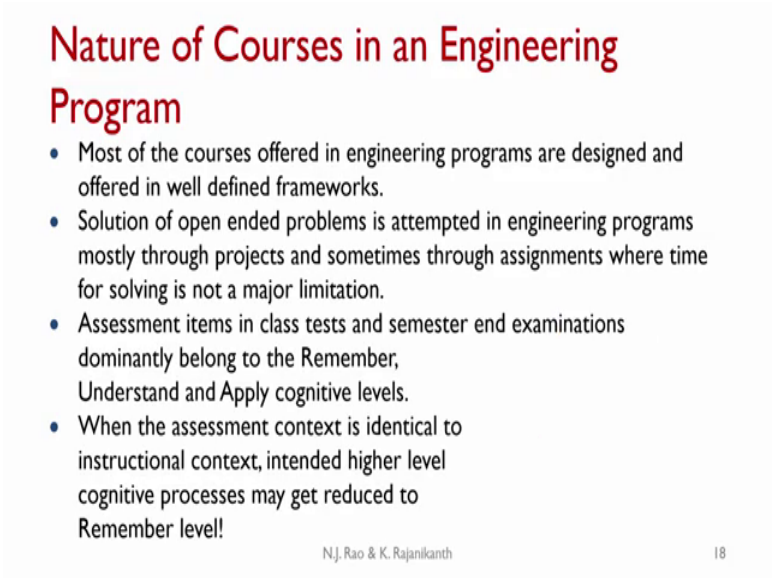

But if you look at the typical courses in a typical undergraduate engineering program, we see a slightly different picture. Most of the courses offered in engineering programs are designed and offered in very well defined frameworks, fix a time, fix at a schedule of assessment and fixed curriculum. Solution of open ended problems is attempted in engineering programs,

mostly through projects and sometimes through assignments, where time for solving is not a major limitation.

Assessment items in class test and semester end examinations dominantly belong to remember, understand and apply cognitive levels. We already saw that it is very difficult to generate assessment items at higher cognitive levels, when the time available for solving them is limited. Thus the fixed duration assessment items generally will be at the level of only remember, understand and apply cognitive levels.

When the assessment context is identical to instructional context, intended higher level cognitive processes may get reduced to the member level. For example, explain is at the understand level. However, if the answer expected from the student to a typical explain type of question is available in a learning resource and that has been discussed in the classroom, then it is quite possible that the student memorizes that expected answer and simply reproduces that during the examination.

Thus, the performance of the student essentially represents a cognitive level of remember only not understand. Similarly, even an apply level activity, if it is a repetition of what has been done in the classroom may sometimes become only a remember level activity. Thus, if the instructional context and assessment context are identical, then even a higher level cognitive activity may get reduced to remember level.

Student might produce the required performance purely working at the cognitive level of remember, rather than at any higher cognitive level. This we will discuss again when we look at the issue of assessment.

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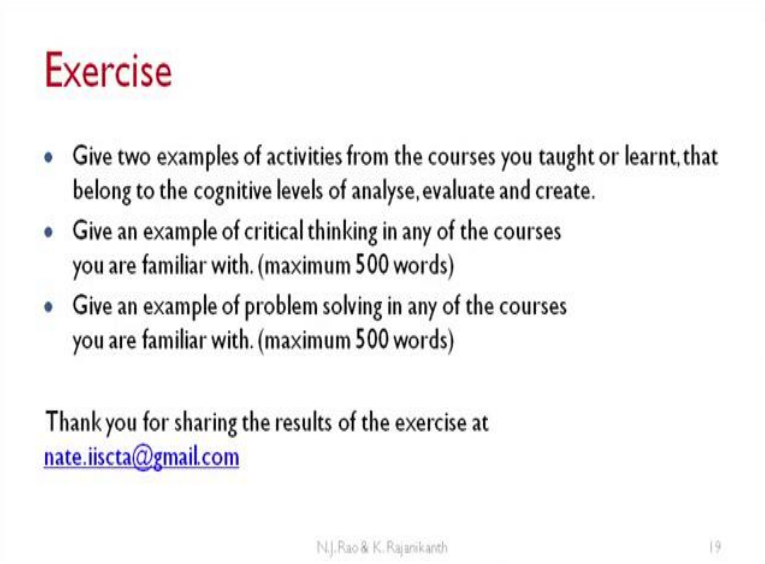

Exercises, give two examples of activities from the course you taught or learned that belong to the cognitive levels of analyse, evaluate and create. When you give these examples, particularly for analyse, please ensure that it is not at apply level but truly at the analyse level of the Revised Bloom's taxonomy. Give an example of critical thinking in any of the courses you are familiar with, with the maximum of 500 words.

Give an example of problem solving in any of the courses you are familiar with, again with a maximum of 500 words. Thank you, for sharing the results of the exercise at nate.iiscta@gmail.com.

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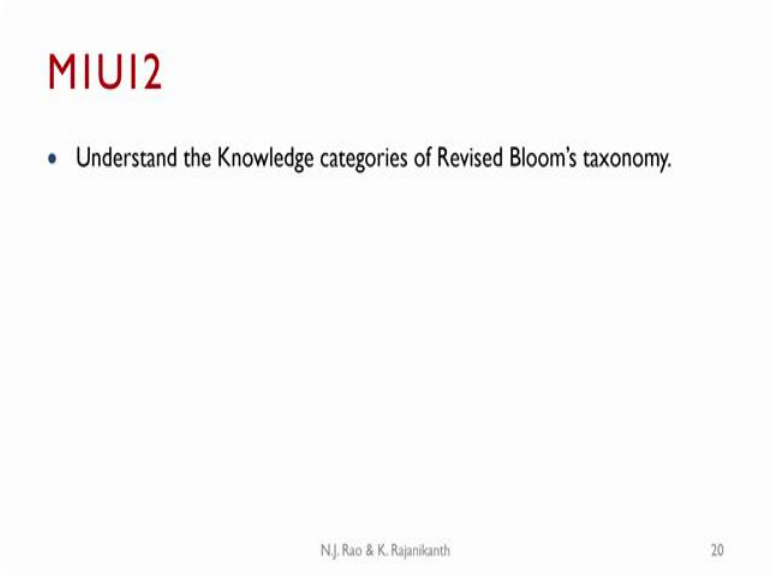

In the next unit, we will understand the knowledge categories of Revised Bloom's Taxonomy. Thank you and we will meet again in the next unit. Thank you.