TALE - 2 Course Design and Instruction of Engineering Courses

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Lecture - 11
Instruction Material and Learning Material

Greetings and welcome to TALE Module 2 Unit11. This unit 11 is part of the Development Phase of ADDIE system design of a course.

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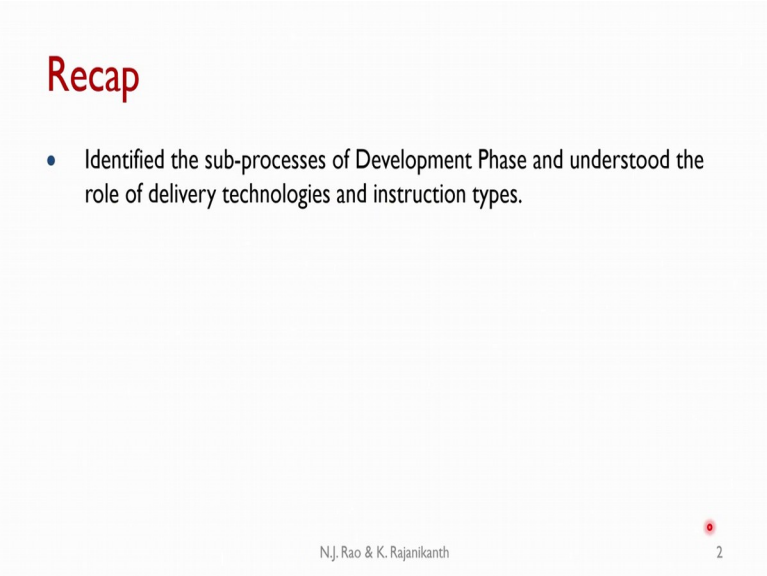

In the previous unit, we looked at the sub-process of Development Phase, understood the role of delivery technologies and instruction types. The two key components from the previous unit are delivery technologies and instruction types. Delivery technologies: while blackboard or whiteboard still is a dominant technology, plenty of new technologies are coming and are available readily. Many institutes slowly started using these technologies. Depending on the technology, the activities of development phase will significantly vary.

While technologies give you certain potential advantages, but to get those advantages, one should understand the role of these technologies with respect to their subject and audience. Obviously, the necessary infrastructure should exist in the classroom. Instruction types are also many. Still the dominant one (let us say more than 95 percent of the time) people use face-to-face instruction.

We have other instruction types namely, blended learning, flipped classroom, and online courses which to a small group of audience are like the course where you are currently participating namely MOOC. There are different instruction types and the way each instruction type gives you a different type of relationship between the instructor and the students. That is where one needs to clearly understand the role of relationship in making effective use of these instruction types.

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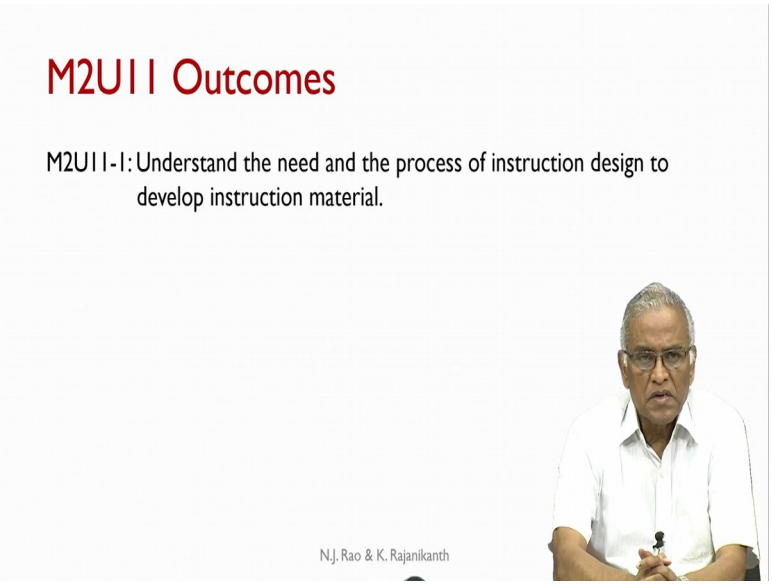

The existing unit is related to instruction material and learning material. The outcome is to understand the need and the process of instruction design to develop instruction material. Learning material is simple and straight forward. The focus is on the need for some design of instruction, based on which instructional material is developed.

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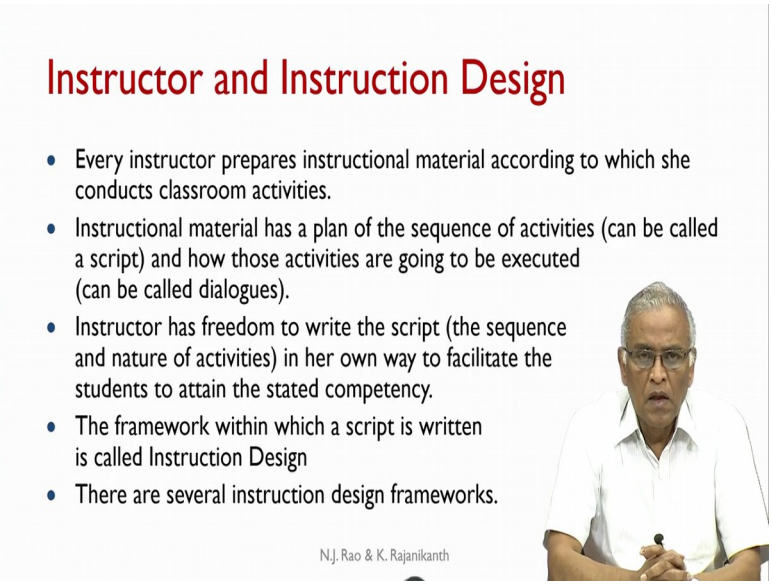

Instructor and instruction design: (We have already mentioned what instruction design is.) Instruction design consists of arranging a series of learning experiences that facilitate the students to acquire or attain the stated outcome. Every instructor prepares instruction material; if he has not already prepared, he will be conducting the classroom activities according to that instruction material.

Instruction material may consist of the material that the instructor wants to write on the board or the slides they want to project or video they want to show etc. But the actual conduct of the classroom activities will be as per the sequence of instructional experiences that instructor planned. Instructional material represents a plan of the sequence of activities (we can call that as a script.)) and how these activities are going to be executed. First write the sequence of activities like a, b. c and so on. For each activity write the material (which we can call them as dialogues.)

Script and dialogues are the two words that are used both in theatre and movies, and they somehow are appropriate words for instruction design. Here, while we talk about availability or need to write a script and then followed by dialogues, but what kind of script do you want to write? That means the sequence and nature of activities instructor wants to have or it is the way instructor wants to do. The decision on this is taken by the instructor.

It is not legislating what kind of script the instructor should prepare. It depends on the nature of the subject, infrastructure, delivery technologies; other resources that are available, and facility the instructor has with chosen instructional activities. There is a huge number of instructional activities available in the literature. Different people have used different activities, and it is not possible to expect an instructor to be familiar with or have a grip on all types of instructional activities.

Each faculty member over time will develop some facility and liking for some type of instructional activity. The script will be based on what the instructor feels comfortable with. Even though the subject matter is same, no two scripts from two different faculty members will be identical. The framework within which a script is written is called instruction design. There are several instruction design frameworks. (We will not exhaustively list them or deal with them.)

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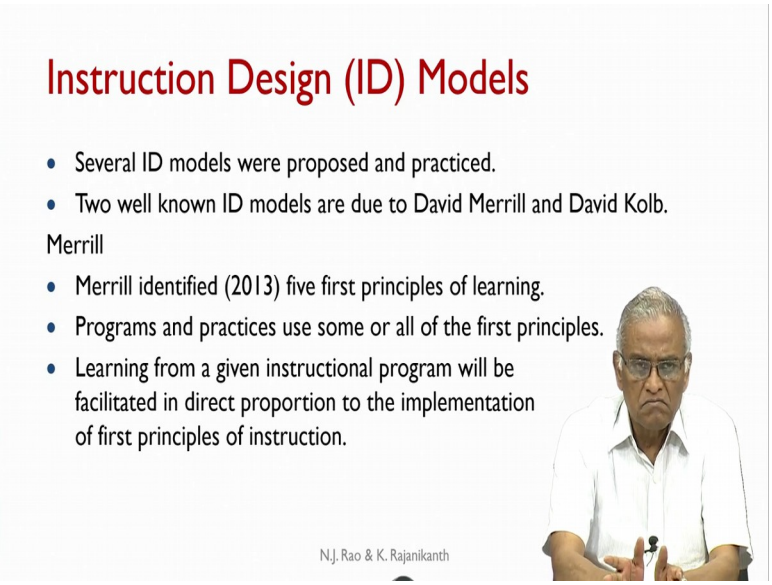

Instruction Design Model is something people have been exploring for the last 60-70 years. There are several models proposed and practiced. We will only mention two out of which will only deal with one which we are going to use. Two well-known ID models are due to David Merrill and David Kolb. David Kolb talks about experiential learning. (We will not elaborate on that) whereas David Merrill identified in 2013 five first principles of learning. The principles of learning do not look very odd. They appear to be obvious.

But he is the one first time has put all of them together. There is a book written in 2013 by him related to this instruction design which is a good source of information. (Programs would mean it could be a workshop or it could be a 4-year program.) Programs and practices use some or all the first principles. We feel that it is possible to use all the first principles and incorporate the first principles into your instruction. But if for some reason you find it difficult to pay attention to one of the principles, still it is worthwhile.

Learning from a given instructional program will be facilitated in direct proportion to the implementation of the first principles of instruction. If you can pay attention or incorporate all the five principles, then learning is best achieved. It is in direct proportion to the way you are using these principles.

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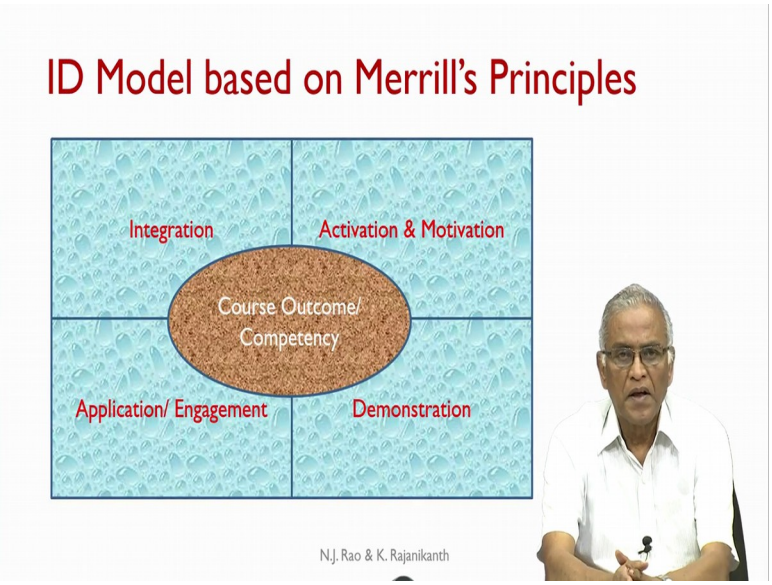

This ID model is based on Merrill's principles; it is not precisely what Merrill proposed. Slightly wordings are different, but mostly the model is the same. The starting point for Merrill's principles is the real-world problem, which is at the center - Real-world problems. The words "Real-world problems" – are replaced with - course outcome/competency. Continuing from there we move on to the quadrants sequentially: activation and motivation, demonstration, application/engagement and integration.

First Activate and Motivate, then demonstrate the new knowledge and skills. Then in the next stage, the student directly applies the new knowledge immediately or at least

engages with the new knowledge. After this, the student integrates the new knowledge or new skill that he has acquired with what he already knows or links it with the earlier knowledge that he has.

This looks intuitively straight forward and clear, but this sequence of activities will have to be gone through in somewhat in a systematic manner rather than in a haphazard way. That is why we require an ID model.

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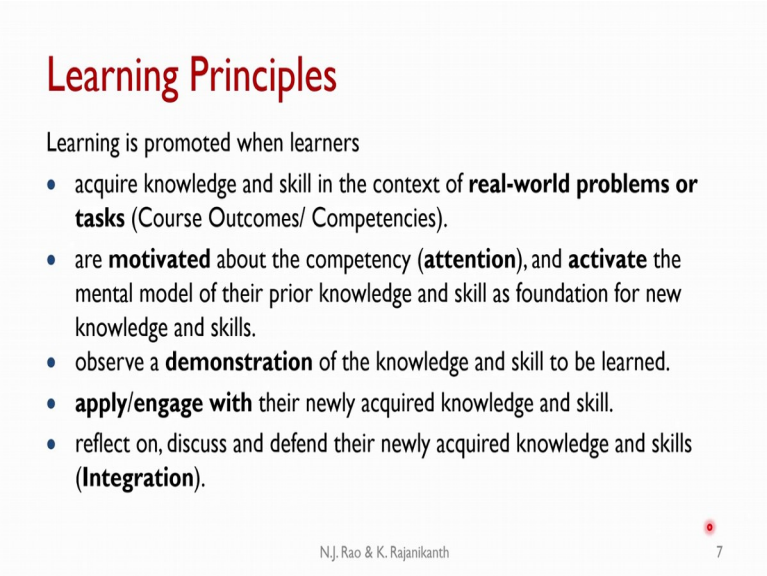

The statements of learning principles (with minor changes in the wording; otherwise, these are the principles as stated by Merrill.) Learning is promoted when learners acquire knowledge and skill in the context of real-world problems or tasks – Merrill's statement.

Real-world problems are tasks for us are nothing but course outcomes or competencies. When we talk about instruction design, competency is a word that we will use because competencies are elaborations of course outcomes. Learning is promoted when learners are motivated about the competency and activate the mental model of their prior knowledge and skill as foundation for new knowledge and skills.

There are two keywords; one is motivated, only when you are motivated you pay attention to what is happening in the class or what is happening in an instructional activity. Without attention, obviously, you already lost the student, and none of the other activities will have any meaning. Then, you activate the mental model of the prior

knowledge and skill of the student which is the second principle. Learning is promoted when learners observe a demonstration of the knowledge and skill to be learned.

The instructor is demonstrating new knowledge. It could be an experiment, or it could be a lecture; it could be presentation of something, a video or even conducting an experiment in the lab, or showing a physical object. The instructor is not lecturing about the knowledge; he is demonstrating the new knowledge and skill to be learned.

Learning is promoted when learners apply or engage with their newly acquired knowledge and skill. Immediately after the demonstration, the students are engaging with that knowledge, or it could be just 'applying' the new knowledge. For example, apply strictly is related to solving a problem whereas, engaging can also be related to understanding activity or any other higher-level activity (that is why we use the word apply stroke engage with.) Learning is promoted when learners reflect on, discuss and defend their newly acquired knowledge and skills. (we will elaborate on each one of these principles a little more.)

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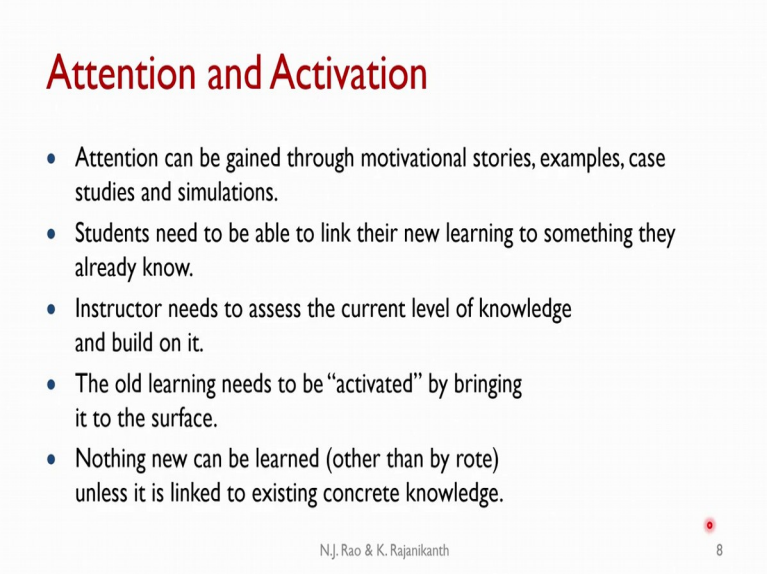

Attention and activation: if I cannot get the attention of the students, whatever that I do subsequently does not serve any purpose. I can blame the students and many factors for not getting the attention, but if I do not have the attention of the student then I lost it right in the beginning. The first thing is how do I get the attention?

To get their attention: if you are able to give a small story of 1 - 2 minutes or give some examples of the activity that you are going actually to present later or you can present as a case study, or you can even simulate something. These days you do have access to laptops and projectors, and so, you can prepare an interesting simulation and get their attention.

Of course, this activity should not take too long. If it takes too long, then you do not have time to demonstrate the new knowledge. After getting the attention, the students need to be able to link their new learning to something they already know. Unless you can link to something that you already know, you will not be able to gather or absorb the new information (that is the way the brain functions.) But you should be able to link immediately any new information to that.

You activate that knowledge to which the new information can be linked. Generally, many teachers already do that by saying, "let us look at or let us review what we have done in the last class," that is one way of invoking prior knowledge. Or sometimes the prior knowledge may come from some subject that the students have learned maybe a semester or year ago or invoking something from a high school subject.

One has to spend a little time to activate and re-present that, that is, if it is in the long-term memory, he has partly forgotten, that knowledge is to be brought to the short term memory area so that you can process that information, or relate the new information to that. As a part of activation, the instructor needs to assess current level of knowledge and build on it; the old learning needs to be activated by bringing it to the surface - invoking.

It is a strong statement "nothing new can be learned unless it is linked to existing concrete knowledge." But in any course or any subject, there is no prior knowledge that you already have and relate to. The only way that one can learn is by rote. That is something presented on the board or something written on a piece of paper. You just mug it up which we consider as kind of learning, and that kind of learning will vanish immediately after the exam is over.

A teacher will have to make a solid attempt to link the proposed new knowledge to the existing knowledge of the students. Agreed that all students will not have the same levels or same knowledge before coming to the class, but that is what one should be prepared to do. (We will not say what happens if many students differ from one another; how do you

take care of it? The only thing that you can say it takes time; if you have it or not it takes time to carry all the students with you.)

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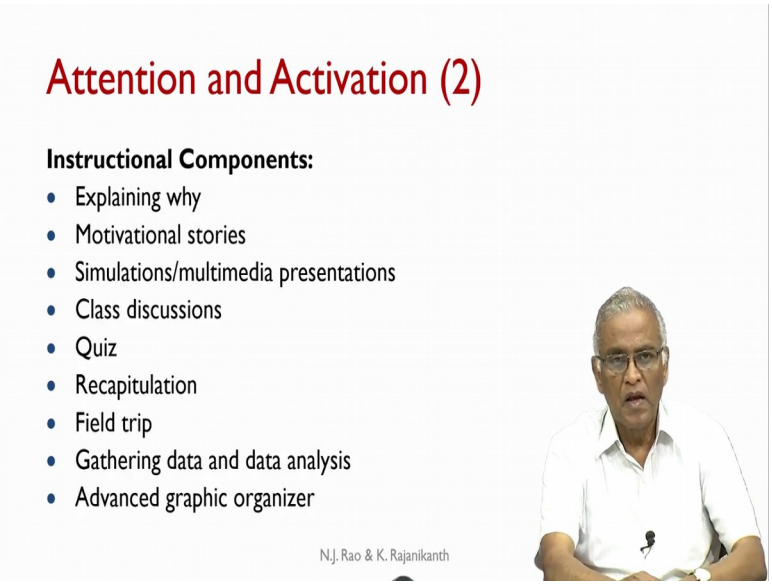

What are the types of instructional components (activities) that you can use under this stage of attention and activation? Explaining why; motivational stories; simulations/multimedia presentations; class discussions; quiz; recapitulation; field trip; gathering data and data analysis; advanced graphic organizers are some of the activities that address Attention and Activation.

One of the advanced graphic-organizer is the concept map. It does not mean that all of them will have to be used all the time. An instructor should decide as to what are the most appropriate ones for the competency on hand.

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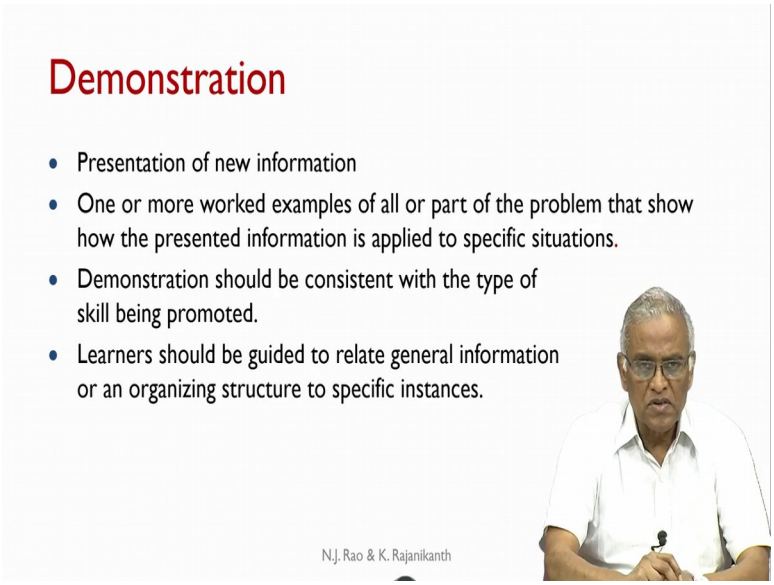

Demonstration is easier for any teacher to understand. as that is what he or she is doing all the time. Demonstration is presentation of new knowledge and skills. It can be presented through a lecture. A lecture and a blackboard or lecture and a PPT presentation through LCD projector etc. One is presenting new information, and depending on the kind of problem that you are looking one or more worked examples of all or part of the problem that shows how the presented information is applied to specific situations. This is where the contribution of the instructor will come.

How many problems do I present; what is the scope of each problem and how do I address all features of the (whatever I consider essential features) competency. Demonstration should be consistent with the type of skill being promoted. If the competency is related to designing an electronic circuit, but if the demonstration focuses on and stops with explaining the function of the circuit, not the design; that means, you do not work out a design example.

Design example will involve stating what is the functional requirement of the circuit; how do you choose components; what kind of alternatives that are available; how do you go about doing circuit design. If you do not go through the design of a circuit then demonstration is not consistent with the competency because we are promoting competencies related to the design of a circuit. The teacher must demonstrate the design of a circuit.

Learners should be guided to relate general information or an organizing structure to specific instances. Specific instances are required rather than presenting a theorem or explaining in general, what is its importance what it is doing and leave it at that. Such information will not stay with the students.

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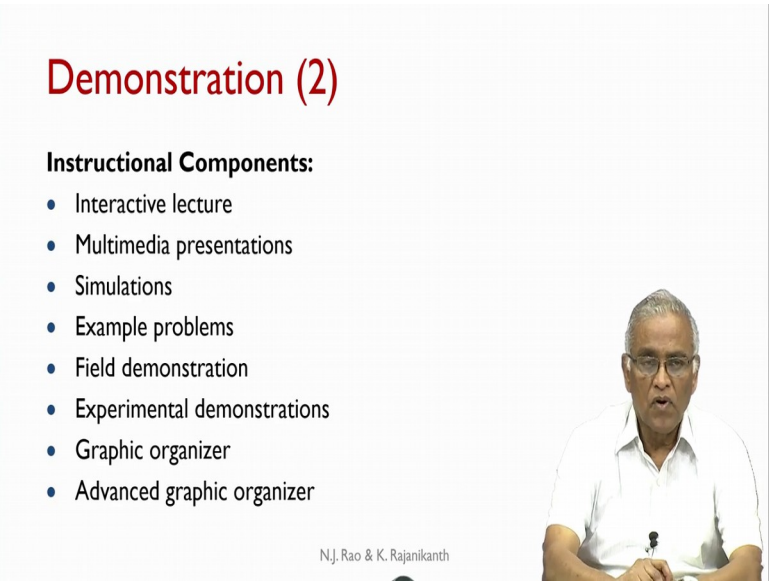

What are the instructional components that you can use? Interactive lecture, multimedia presentations, simulations, example problems, field demonstration, experimental demonstrations, graphic organizers, or advanced graphic organizers. (To say graphic organizer is nothing but a graph or a table or some block diagram; advanced graphic organizers could be topic maps; concept maps etc.)

(We will once again go through some of these instructional components in module 3.)

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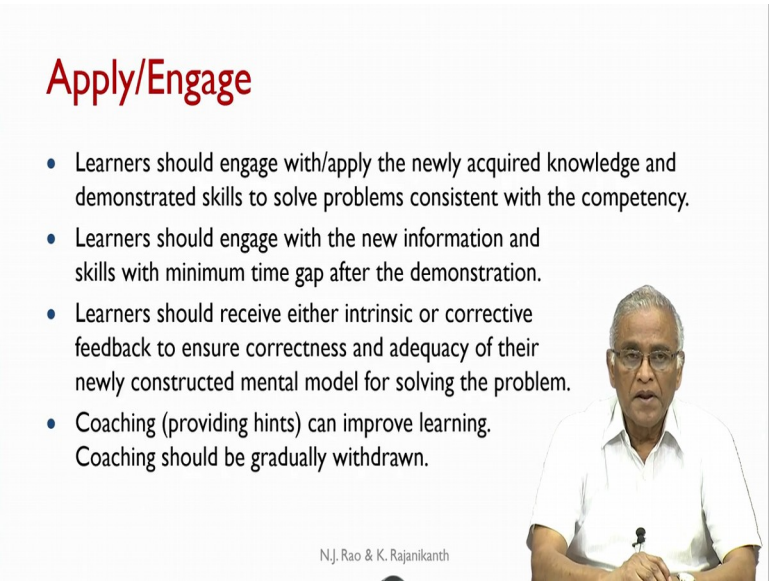

The primary issue, learners should engage with or apply the newly acquired knowledge and demonstrated skills to solve problems consistent with the competency. That means, once again taking the earlier example, if the competency is related to designing an electronic circuit, the student should immediately apply that knowledge of designing a circuit. However simple it is, but it should be immediately applied.

One of the fundamental learning principles is a learner should engage with the new information and skills with a minimum time gap after demonstration. (You cannot say I am explaining now. We will apply this knowledge a few days later or maybe at the end of the semester or sometimes there are some courses where you stop and say we will apply this knowledge in a course 3 semesters later.)

(That is the wrong way of designing a curriculum, where the knowledge that you are imparting is not immediately applied.) The time gap between demonstration and application should be as small as possible. This is an important principle typically not followed by majority of the teachers because they feel that presenting information in an interesting way and leave the application of information to the student to do it at home. This does not work satisfactorily.

There is another principle - you make the student apply the knowledge without understanding all the theory behind it. You first make him apply the knowledge and then, present the knowledge. That is, what we are doing right now in this course - we are

presenting your methods of doing and assuring you there is a lot of theory behind it. We are not explaining all the theories and what research has been done. We just say almost like asking you trust us saying that these are well-researched principles based on which we are presenting you new information.

While the students are getting engaged with the new knowledge, the instructor or the student should receive either intrinsic or corrective feedback to ensure the correctness and adequacy of their newly constructed mental model for solving the problem. When you are engaging, students are linking new information to their existing body of knowledge or existing mental model.

While they are engaging/applying, there is a possibility they make some errors, and the corrective feedback should be provided. Coaching or tutoring or providing hints and so on can improve learning. If you want the student to internalize the knowledge, the coaching should be gradually withdrawn.

You must be smiling while reading this, where is the time for all these; how do you handle 60 students in my class and where do I have the time in the classroom to meet the requirements of every student. Yes, you do not have, and that is what the challenge is. How to address this challenge is a different issue. But the use of some technology can significantly support this.

We will talk about some of it in module 3, but it is always a problem and especially if you have students with widely varying abilities, to cater to the low end as well as high-end students in the given time is not easy, and many times it may not be possible. You should use other means to carry all the students with you.

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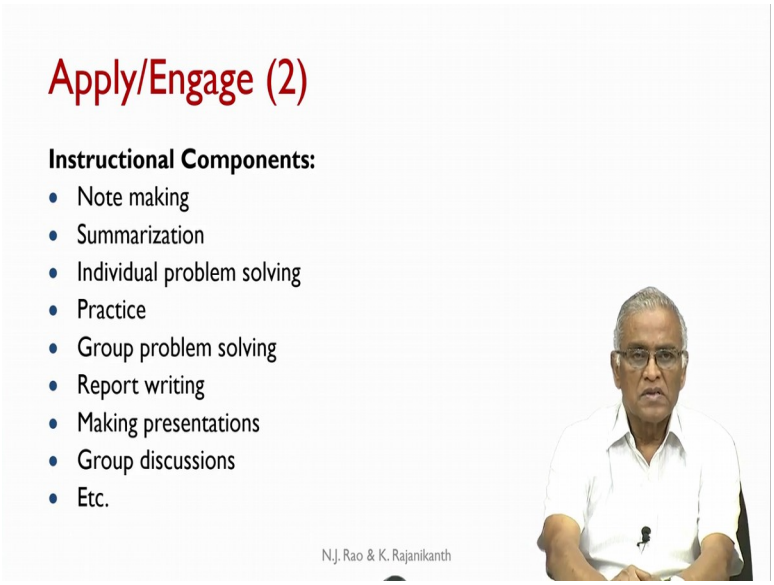

The instructional components of apply and engage include note making (that is you may ask these students to write a small note,) summarization, individual problem-solving; practice, group problem solving, report writing, making presentations, group discussions and many more. (These are some of the instructional components which we will deal within the following module.)

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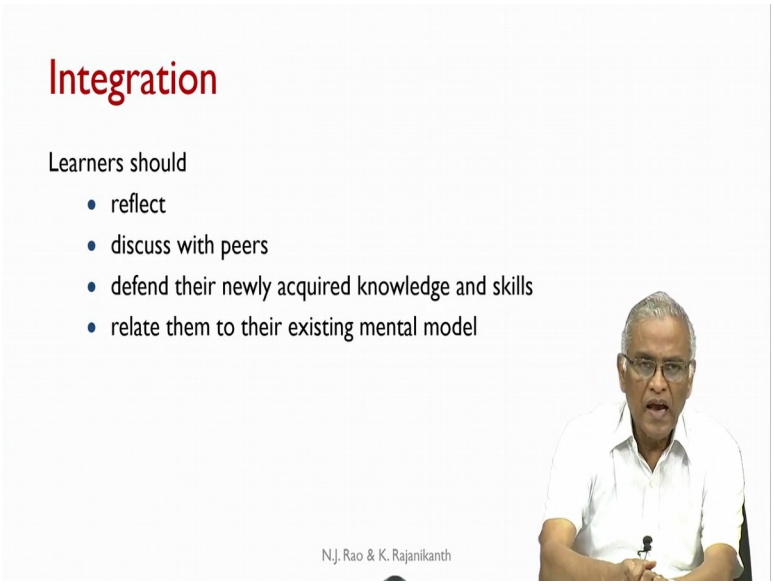

The learner should reflect a little bit what they have learned; that means, kind of internally a look at it what is it that he/she learned and why is it important; under what

situations he/she uses this information, or did he/she understood it correctly? There is a reflection that should be done by the student. In this process, the learner may want to discuss with the peers.

You talk to your neighbor, or it could be as a group of 2/3 people. If you have taken a position, you should be able to defend that. Yes, my understanding is correct. Then finally, relate them to their existing mental model. (This is the process of integration.)

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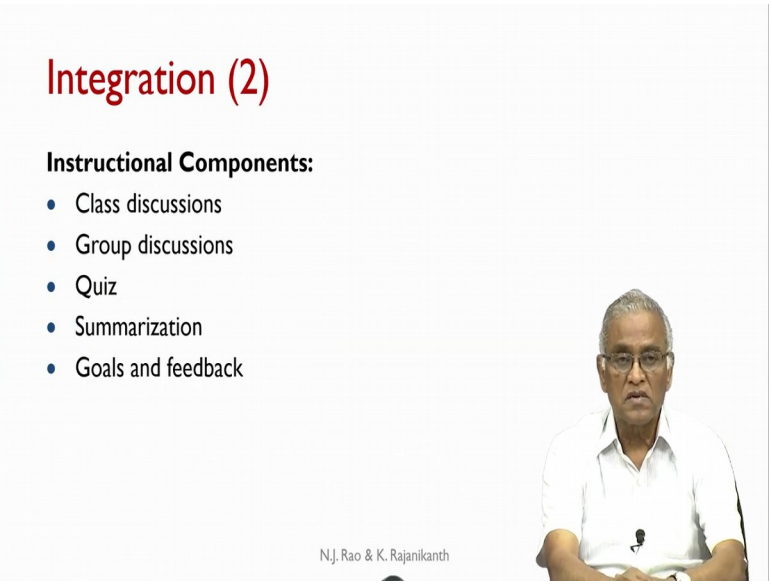

The instructional components can be class discussions, group discussions, quiz, summarization and (you also state the goals and how far you have come with respect to the goal and where you are and how far to go) goals and feedback.

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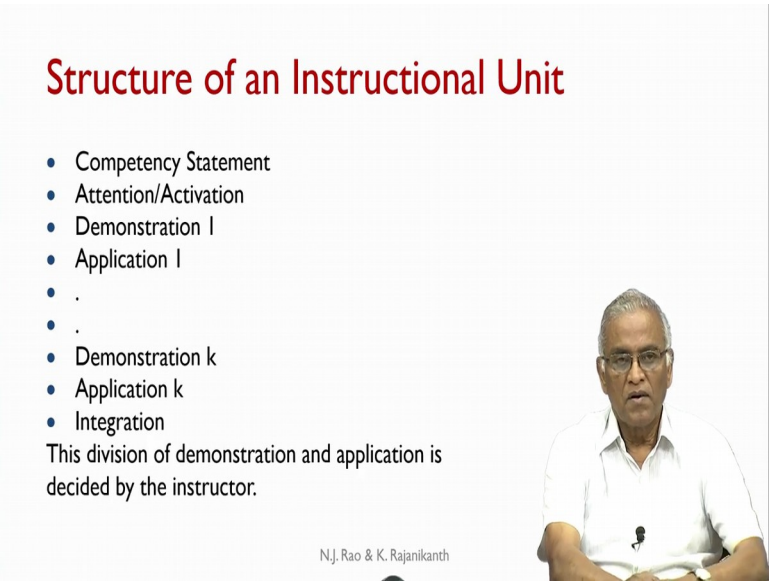

Structure of an instructional component: what sequence do we go to? The first thing is competency statement which we are all familiar with. Then the first stage is attention and activation. Let us say a competency is an instructional unit; it can be 2 to 4 hours duration. A 4-hour instructional unit cannot consist of 3 hours of lecture, and few minutes in the beginning and in the end are making the students use the knowledge. The time gap between demonstrating new knowledge and applying it should be as small as possible.

We will break the instruction unit as indicated. The ‘attention and activation’ stage, is followed by a small demonstration and a small application, stage, and have a series of them. In a competency you may not require more than 3 such elements of demonstration followed by application. After such a sequence the learners should be integrating the knowledge. The division of demonstration and application is entirely decided by the instructor. It takes some practice, and these are best done as group of faculty or at least 2 faculty interacting with each other.

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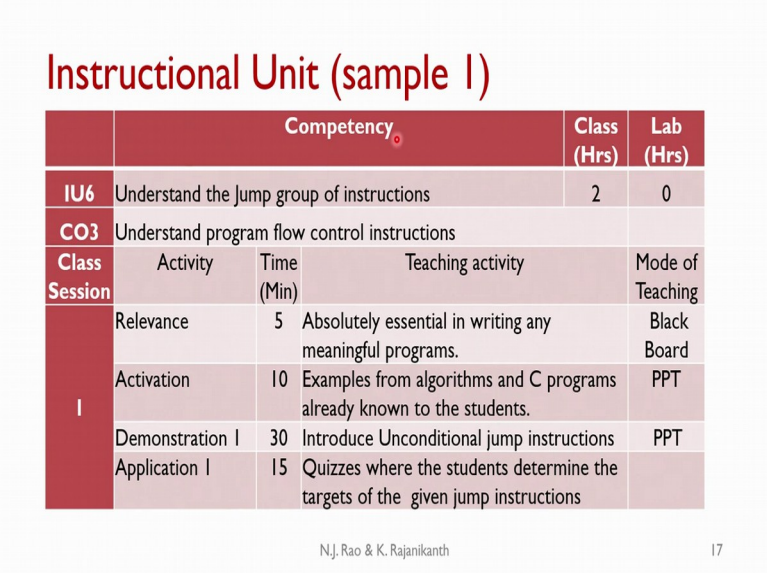

Example of instructional unit: this is how the script for an instructional unit is drawn/ prepared, a table will be a good way of representing the script. This is instructional Unit 6 of a course on programming, "Understand the jump group of instructions" - competency statement; scheduled for 2 hours, and there is no laboratory associated. This competency is part of understand program flow control instructions. Under CO3, there are other instructional units.

There are 2 hours; I take about 5 minutes to explain the relevance of the competency: understanding the jump group of instruction is necessary for writing meaningful programs. Here we decided to use the blackboard. Maybe I will show an example and say this is how the jump instruction is relevant.

Activation: I take about 10 minutes to present examples from Algorithms and C programs already known to the students using a PPT. Then I do demonstration -1 for 30 minutes consisting of introducing unconditional jump instructions through a PPT. Then, I allocate 15 minutes for the student to apply that knowledge immediately. This can be in the form of a quiz where the students determine the target of the given jump instruction. When they are applying the knowledge, they are not applying it to all conceivable situations that one is likely to encounter, but they are immediately getting engaged with that knowledge. If I have only 15 minutes; how do I go about doing it? That is a challenge. It depends on the kind of technology that you are using.

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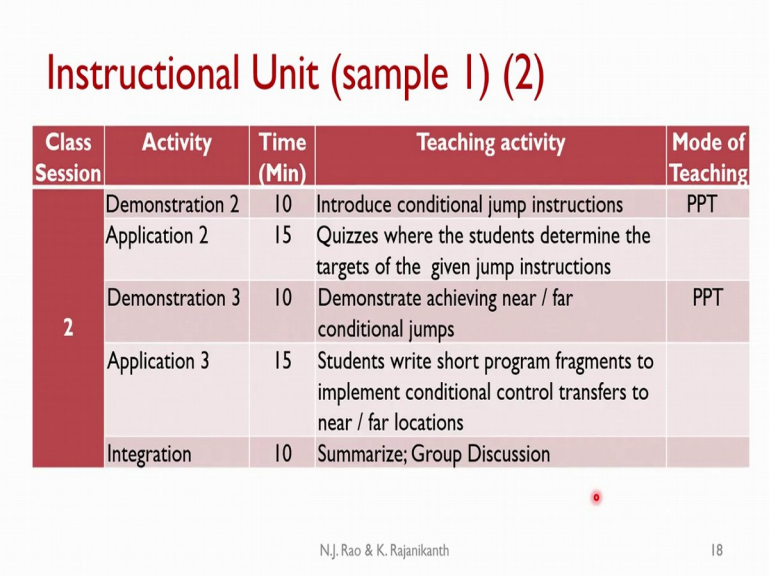

Classroom session - the second hour. I will just give you 2 minutes for you to read through that.

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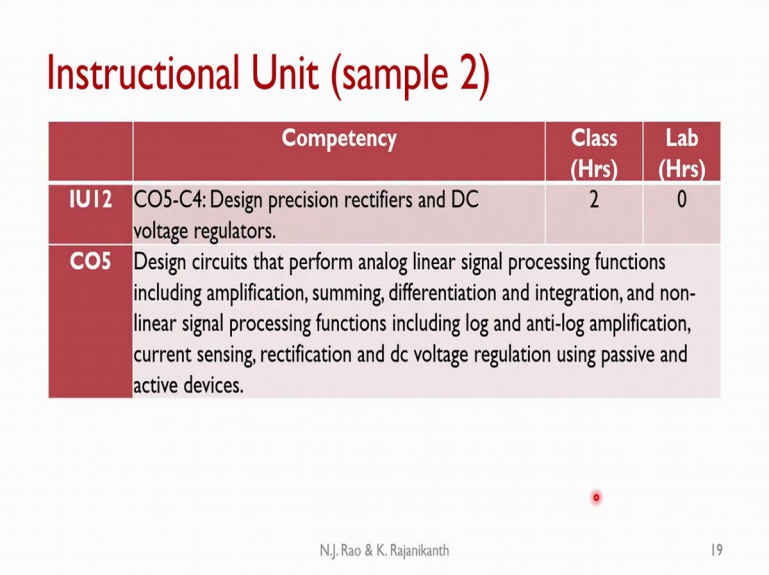

Another example: instruction unit U12, under CO5. Under the CO5, we have 4 competencies. C4 is related to design precision rectifiers and DC voltage regulators. 2 hours of class is required. CO5 is a much longer statement, where design circuits that perform several analog linear signal processing functions.

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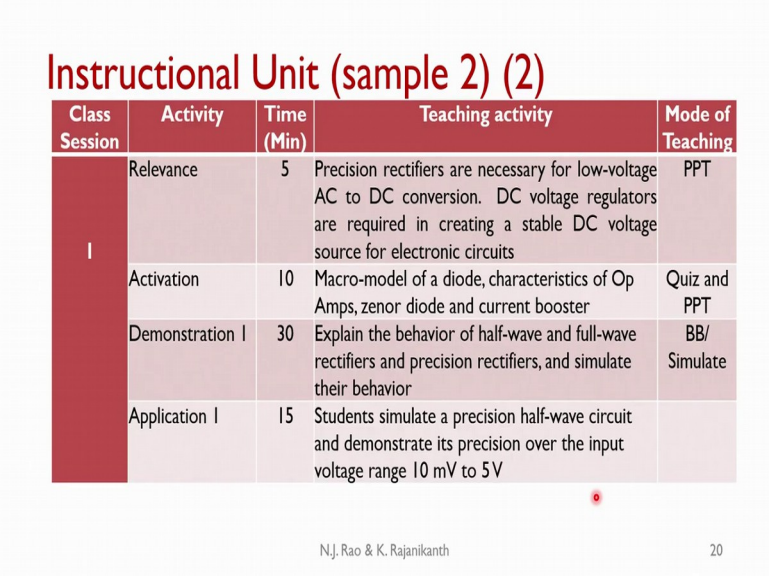

Take the first hour that includes relevance, activation, a demonstration, and application. Here in terms of application, students will simulate a precision half-wave circuit and demonstrate its precision over the input voltage range of 10 millivolts to 5 volts. The application requires the students to simulate something, which requires access to a laptop.

Here the application of the new demonstrated knowledge will require actual simulation, which means the students have the necessary devices with them and they are connected to the internet, and the circuit that needs to be simulated is already made available to them. They are only looking at the behavior of the circuit over a specific input voltage range, and that is the script here.

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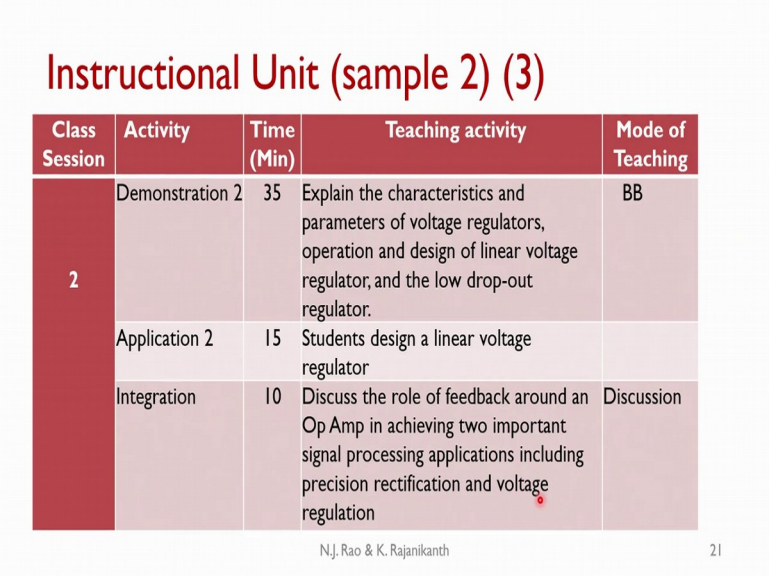

(Second hour again, I will give 2 minutes for you to read through.) We had 2 demonstrations and 2 applications and finally, we are integrating, for which we allocated 10 minutes. What are we doing here? Discuss the role of feedback around an op-amp in achieving the two important signal processing applications including precision rectification and voltage regulation; that means, there are 2 analog signal processing applications; one is precision rectification and voltage regulation.

These two are achieved by using an operational amplifier, and we are achieving that mainly using the feedback. Understanding the role of feedback is necessary for the student with regard to 'analog circuits and systems,' and that is where the integration takes place (we go through the process of discussing the role of feedback.) We have given you two samples of writing a script for instructional units.

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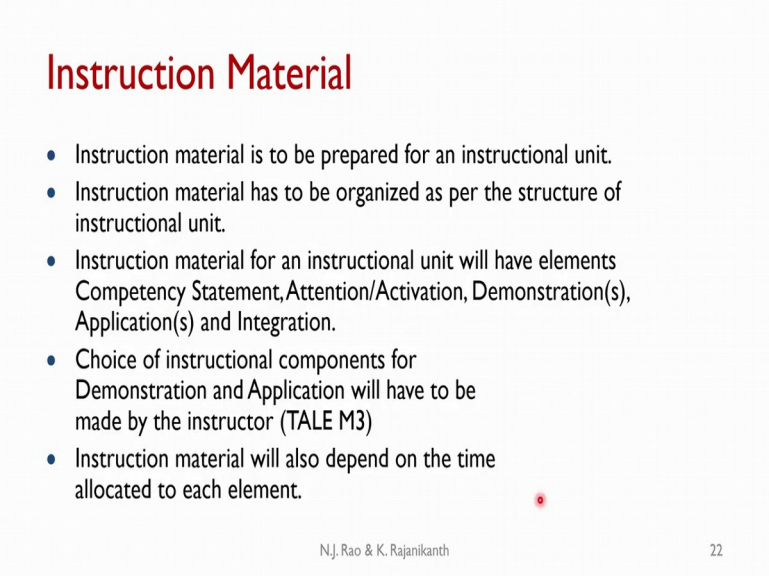

Now, coming to the operational part, instruction material is to be prepared for an instructional unit; that is how we identify, and instruction material has to be organized as per the structure of the instructional unit. That means when you are writing you can put title like attention and activation. Under that write what exactly you plan to present for getting the attention of the student or motivate them. Then, we write below what are the activities that I am planning for activation of the prior knowledge.

If I am doing a quiz, I must write what the quiz is, or if I am presenting a discussion, I must structure that discussion. Because mind you, the time is very limited in the classroom and one can get carried away. If you start a discussion the things can go quickly out of hand and a lot of time can be lost, and that is the reason why you have to write the script very clearly.

Instruction material will consist of the competency statement, attention and activation, demonstration, application (which may be more than one), and finally integration. Under each one we are using some limited number of instructional components, and you should prepare the material according to the script. The choice of instructional components for demonstration and application will have to be made by the instructor.

The instruction material will depend on the time allocated for each instructional element. That is how you should prepare your instructional material. We may be doing some of it intuitively. But when you do it intuitively, we may or may not pay equal attention to all instructional units and all activities. So, if you can create a template for yourself for an instructional unit, then you can start filling it up so that you are not leaving anything to chance.

Once again, the first reaction from the many faculty will be that you are straitjacketing teaching and learning. It is not straitjacketing; it is to assist you in creating your own guideline for yourself. That way, you do not leave certain elements to chance, or you do not depend on the chance to do a good job.

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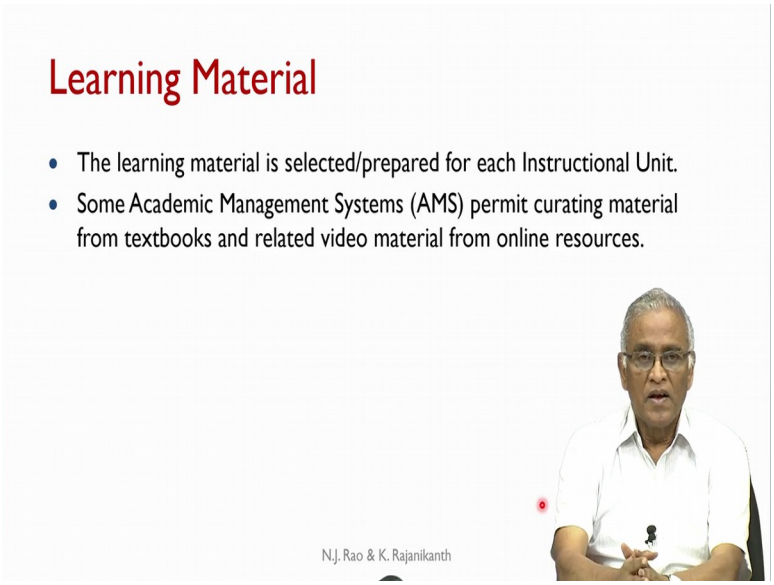

Learning material is not that difficult to understand. Let us consider the example of the Instructional Unit on electronics wherein one is attempting to design some precision rectifiers and voltage regulators. I may be using this material from an identified textbook or some internet resource.

So, what do I do? I select the material by listing the page numbers from the selected textbook, or I give you the internet links with some annotation, or if I think that none of the material that I find in the textbooks is satisfactory, I prepare the material and make it available to the student.

So, either you are selecting or preparing the learning material. Of late several academic management systems are coming into the market. They permit you to curate the material from textbooks and related video material from online resources. I say page 76 to 85 is the related material from the identified textbook. Now, I can put the entire book on my server or I can only take those few pages and link it with my particular instructional unit.

Similarly, I do not want to present a 30-minute video available on the internet. The only 3-minute portion is relevant. Now are tools available to clip 3-minute presentation from the 30-minute video that is available on the internet and make it available as learning material. So, you do not have to go through watching the entire 30-minute video. So, some of the academic management systems permit the instructor to curate the material and make it available to learners.

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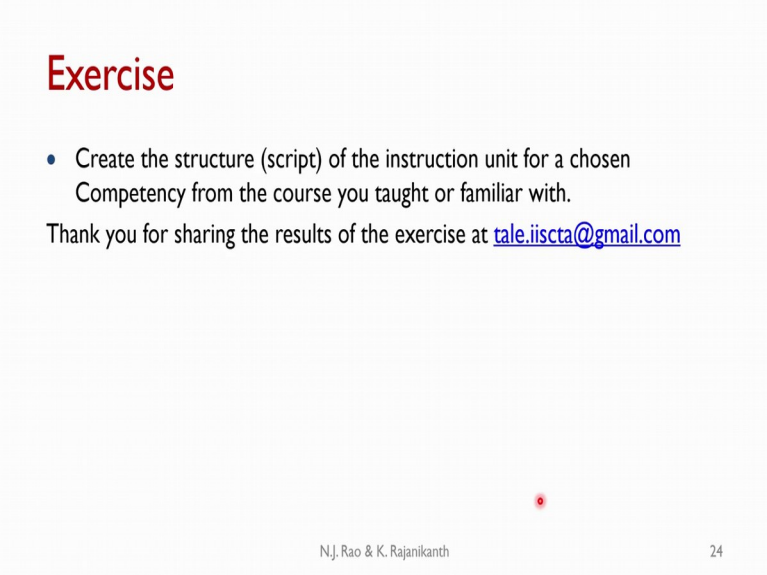

So, we request you to try an exercise that will be an interesting one. We have done this with maybe a few hundred faculty members, and they found it an enjoyable experience. Create the structure or script of one instruction unit for a chosen competency from the course you taught or familiar with. You please try doing that essentially creating the table; table that we have given you and would appreciate if you share the results of your exercise.

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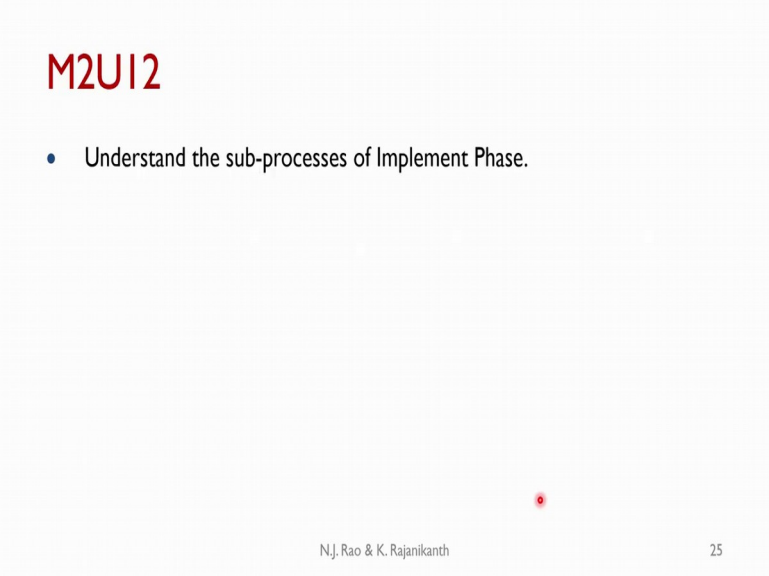

And in the next unit 12, we move on to the next phase and understand the sub-process of implement phase.

Thank you very much for your attention.