TALE - 2 Course Design and Instruction of Engineering Courses

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Lecture – 25
Instructional Components 2

Greetings and welcome to Module 3, Unit 7, which is the continuation of the previous unit - Instructional Components. The instructional components are elements of instruction that can be combined in the way the teacher prefers, and also depending on the particular topic under consideration or the course outcome that he is instructing. Depending on the other situational factors as well, the teacher will combine or sequence these instructional components in the way he prefers.

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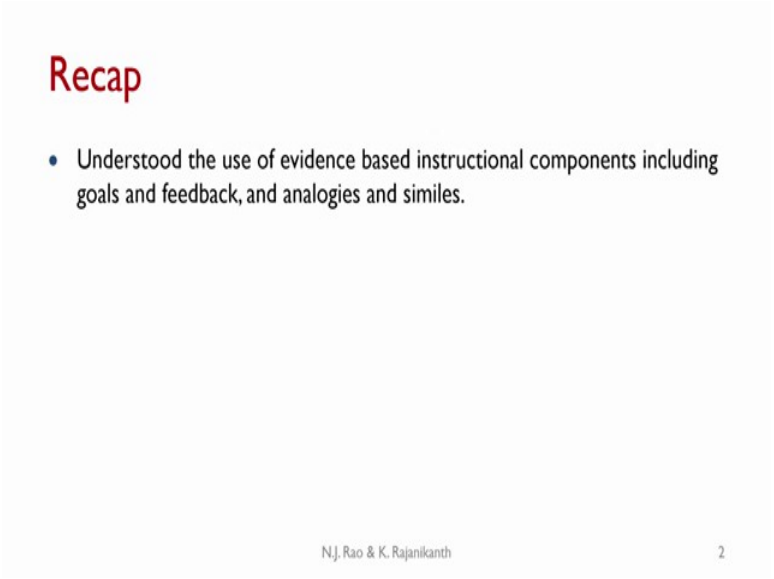

In the previous unit, we looked at instructional components that we considered very important ‘goals and feedback’ and ‘analogies and similes.’ These are the two instructional components that we looked at.

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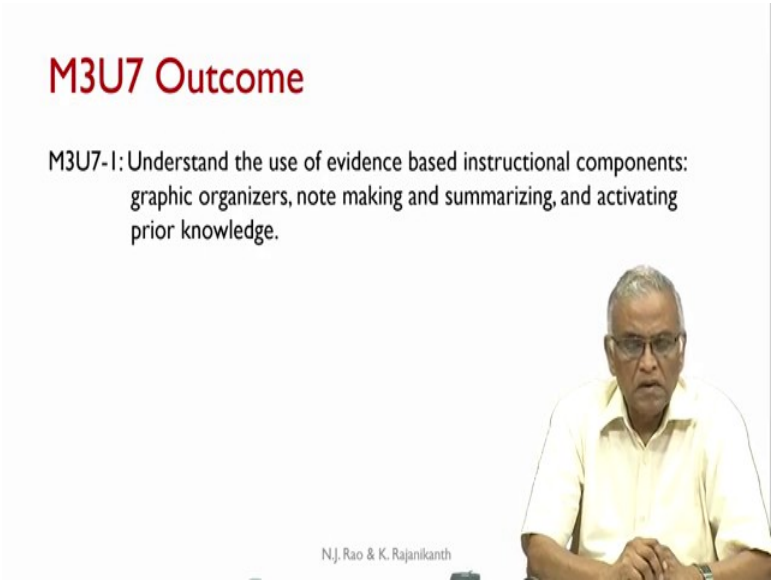

In this unit, we will look at instructional components: graphic organizers, note-making and summarizing, and activating prior knowledge. One can create or even there are many other instructional components that can be considered (we are not presenting every one of them.) In the previous unit, we made a list of about 19 components, that is not at all exhaustive, one can also create one's own instructional component.

Let us look at these three, which can make a significant difference. Why are we taking these? These are the ones where the student is engaged with the knowledge that he is trying to acquire. It is beyond passive listening in a classroom.

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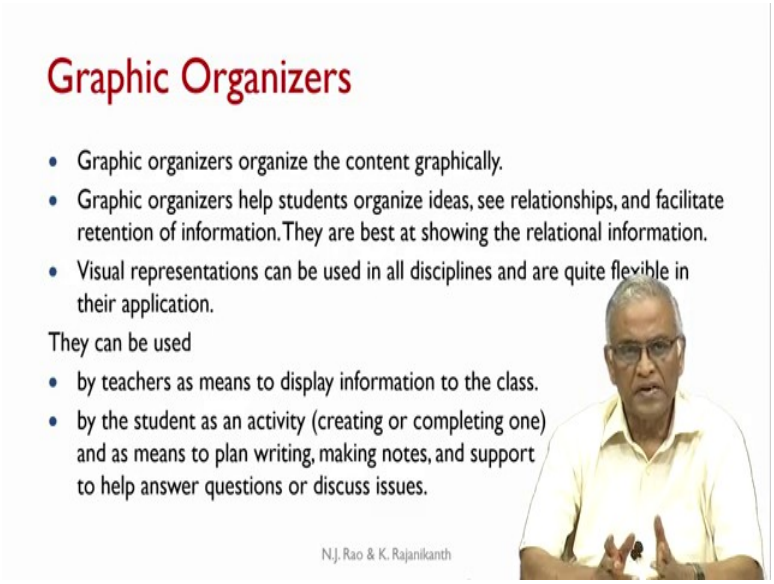

Graphic organizers: Graphic organizers merely organize the content graphically. What do we mean by the content here? It can be an entire course. or it could be only a single 'course outcome,' competency from a course outcome. or the content could be just one single concept as well. It could be a procedure.

How do I do it? We are interpreting the word 'content' here in a very generic manner. Graphic organizers help students organize ideas, see relationships between ideas, and facilitate retention of information. Our primary purpose in instruction is we not only want our students to make sense of what you are instructing, but we want them to retain that knowledge.

Depending on the kind of graphic tools that you are using, they can significantly facilitate the retention of information. That is the primary goal of any instruction. Graphic organizers are best at showing the relational information: how one is related to the other. This visual representation can be used in all disciplines and quite flexible in their application. As mentioned earlier, one can sketch, or one can use a computer-based tool to create graphic representations.

These graphic representations can be used by teachers as a means to display information in the classroom. It can also be a part of a set of slides, as we will see that can be presented in an online course as well. They can be used by students as an activity, either creating an entirely new graphic representation or completing a partially created graphic

representation. A teacher can actually give an incomplete one and ask the students to complete; that means a student is participating in an activity.

Students can also use it as a means to plan writing, that is, if you want to organize or if you are required to write a report or an essay that can be planned in a graphic manner. Some diagrammatic representation can be used even to discuss issues among several people.

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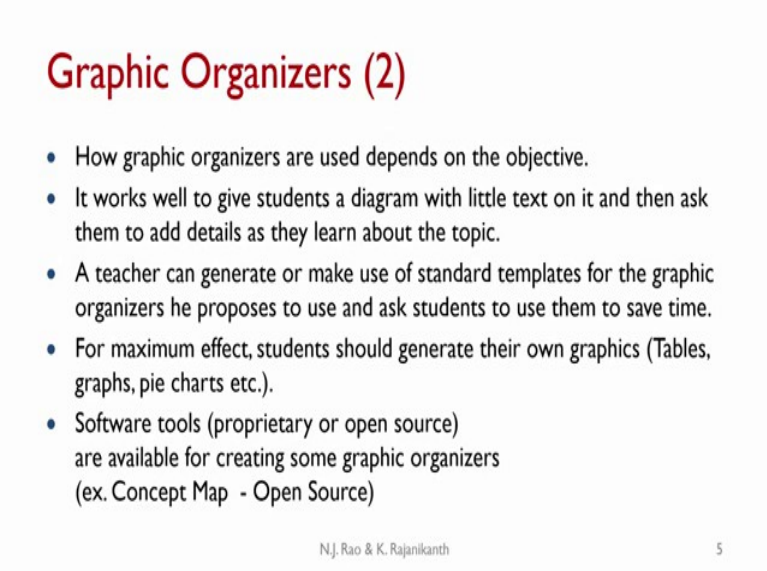

How graphic organizers are used depends on the objective. Are you discussing or you wish to show your understanding to others, or want to present the relationships between the ideas that are under consideration. It, therefore, depends on the objective. It works well to give students a diagram with little text on it, and then ask them to add details as they learn about the topic. (We will presently see an example.)

A teacher can generate or make use of standard templates for the graphic organizers (he proposes to use) and ask the students to use them to save time. There are several templates (available on the internet, or you can create your own template) for graphic organizers. You can share it with the students, and students can actually use them. For example, one can use Google docs; and it can be circulated to all the participants, and they can start working on it while the teacher is presenting in the class.

For the maximum effect of graphic organizers, the student should generate their own graphics in the form of tables, graphs, or pie charts. Software tools, proprietary or open-source tools, are available for creating graphic organizers. For example, the concept map, which we have briefly mentioned in the previous module (we will once again present) is an open-source software tool for graphic organizers. Similarly, you have a tool for mind maps, and so on.

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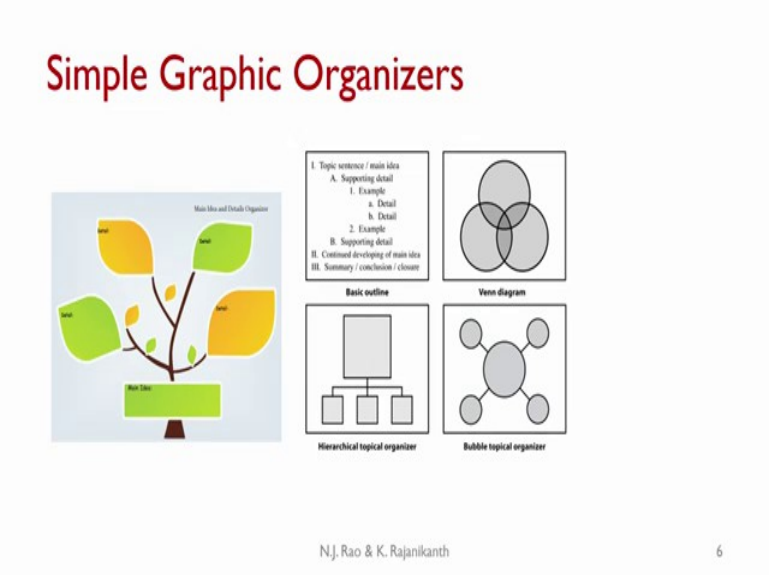

Let us look at some simple graphic organizer. Here this looks very color full - all that is here is, there is a significant idea, and there are several ideas associated with it as a part of it. One can write a significant idea as a text actually in this box.

So, one can write one idea in each one. Or on top of that, you can also write in a kind of indented fashion hieratically, and any topic can be elaborated like this. Though this is textual, by just indentation, you are graphically organizing the information. There are several ideas associated with this. Then there is what we call the Venn diagram. I am sure all of you are familiar with it.

Each circle represents one concept, and there is some overlap between two circles. It can be used really to compare and try to explore what is and what is not by using the Venn diagram.

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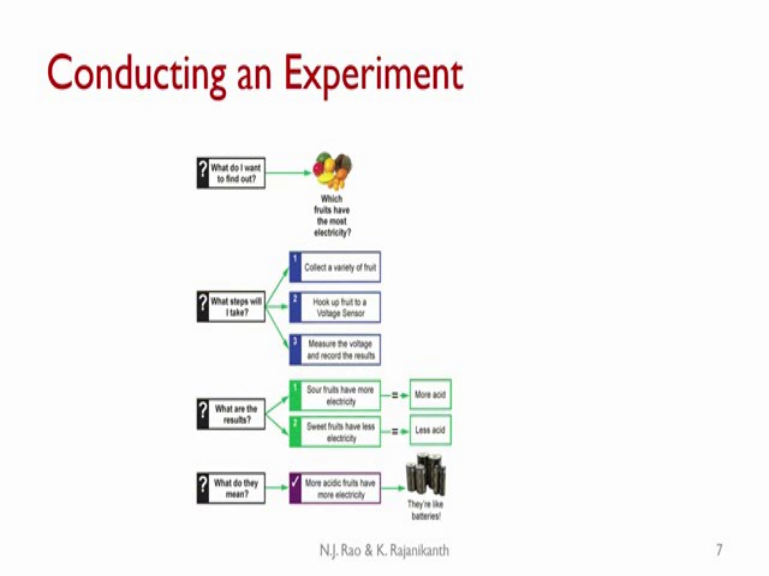

There is another way of representing a simple experiment; that is when you are doing something in the laboratory, an experiment, here you say what the steps are that you will do - 1, 2, 3, 4, etc. Then what are the results that I am going to look at? I measure the results, and I will write/classify these results into different categories, then for each category, I come to a conclusion. By saying this, I am writing my conclusion like this. So, this is one graphic way of representing how an experiment can be done.

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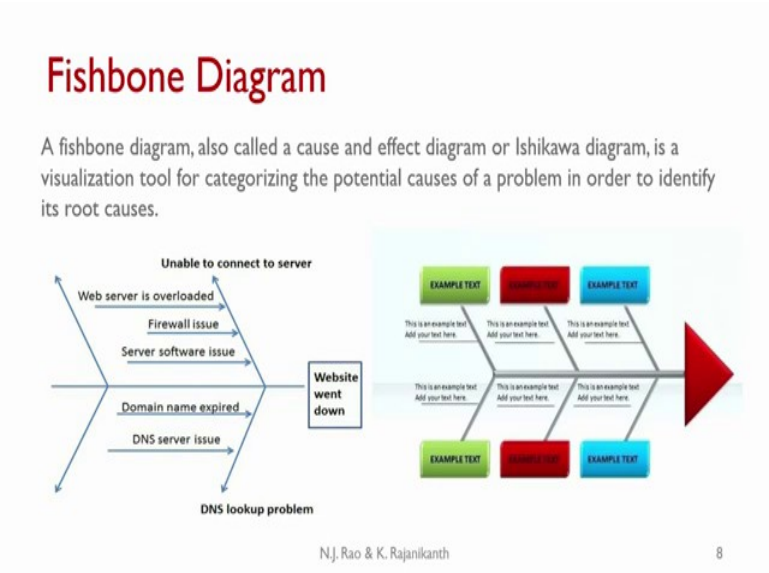

Another one is a fishbone diagram; it is also called cause and effect diagram or Ishikawa diagram, which was initially much used in a management type of issues. It is a visualization tool for categorizing potential causes of a problem in order to identify the root causes. Here, for example, you draw one spine to represent a problem. There are several possible causes, and each major cause will be one spine. I can divide each cause into several possible sub-causes. One can create a very-very elaborate fishbone diagram, through which one should be able to trace the actual cause(s).

For example. the problem is that a website went down. One is unable to connect to the server. It can be due to one or more causes. Can I list all the causes? If I am familiar with the website creation and the software related to that, I should be able to find this. Sometimes groups of people can discuss and identify the root causes. This is a very effective tool. You can take each one of the causes and further elaborate on different sub-causes. For example, the webserver is overloaded. Why is it overloaded, what can be the causes, one can further elaborate this.

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Getting back to Venn diagram, let us say here you have two circles A and B. And when this is A union B, now one of my favorite things is A we call it science, let us say, and B we call it engineering. What is that is common between the two? Can I put some activity in this a circle that does not have an intersection with A? What are all the activities that you can call engineering, but not really science activities? For example, all of the

engineering science part can be part of the intersection. There are some activities that are exclusively in science and are not part of engineering.

I can expand further. I can have three circles, here again, continuing this example, science, engineering and technology. What are the interactions, what kind of activity? Here in this case where all the three are involved, where only two are involved in the other intersections. If you want to expand further, you can have four – science, engineering, technology, and economics. So, the Venn diagram can be used effectively, and as you can see more and more, circles can be added to make it a very rich one.

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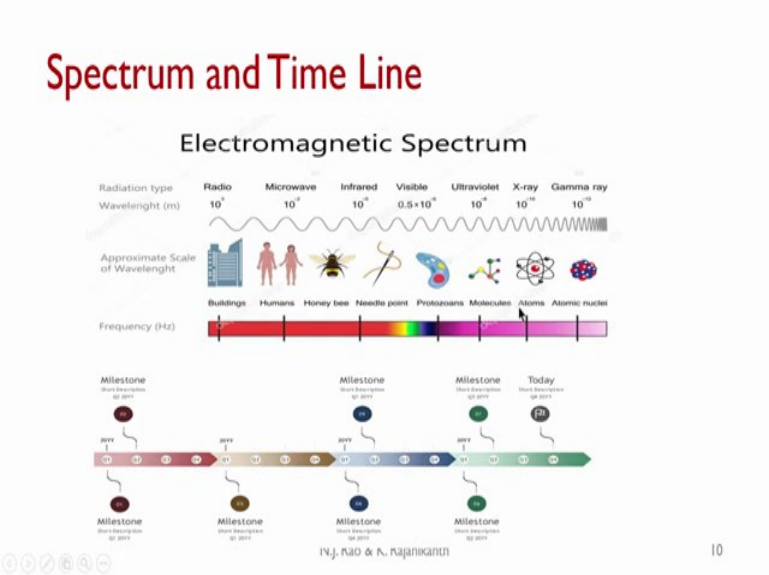

One can graphically represent something in the form of a spectrum, and it is a graphic representation. It provides a mental fix where exactly something is. For example, if you say here under the microwave, we have put humans. What does it mean? The length of the wave - wavelength here is of the order of human beings. Like that, you have examples of all the way up to gamma-rays in the spectrum. It is a good representation. Colors are used to make them attractive. Sizes are represented by things that we are familiar with.

Similarly, when something happens over time, one can identify all the milestones at various times. For example, if you have an engineering project. I can talk about the timelines, and I can also identify milestones in that. So, that way, it can be used for planning a project, especially when a group of people is involved in implementing it.

Identifying milestones at various points of time is a very good way of graphically presenting or planning a project. For this kind of thing, you have tools available for project management.

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Another type of graphic tool is storyboard. A storyboard is a graphic organizer in the form of illustrations or images displayed in sequence for the purpose of pre-visualizing an interactive media sequence. You present your thing as a sequence of images or sequences of even text, or it could be a sequence of computer screen printouts.

The storyboard is used, for example, in identifying the specifications for particular software development. During the specifications phase, screens that the software will display are drawn either on paper are using other specialized software to illustrate the important steps of the user experience. This is very much used in software development.

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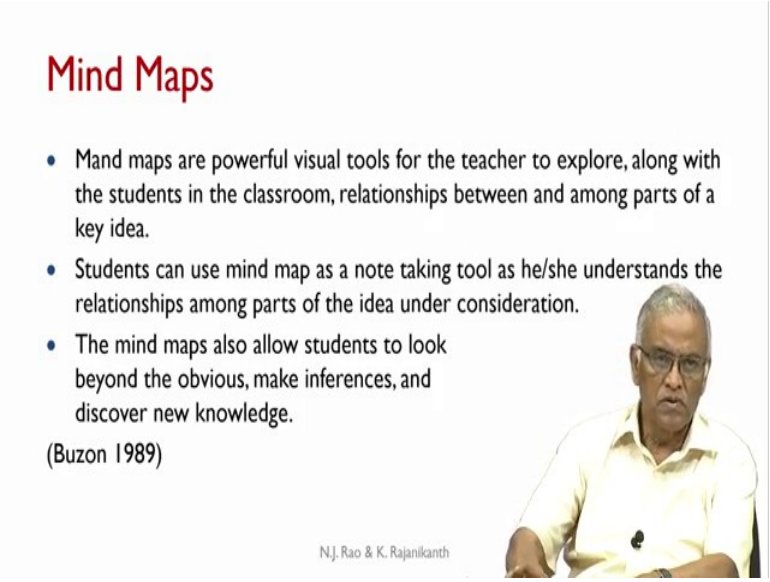

Mind maps: Mind maps are powerful visual tools for the teacher to explore along with the students in the classroom, relationships between and among parts of a key idea. I can ask the students what do they think about an idea or an object I present in the class. I can keep on building a mind map, and you can see how one thing can be related to the other. (using the mind map). The teacher can intervene if the students some relationships are wrongly identified and correct the mind map.

Mind maps also allow students to look beyond the obvious, which means, something I am dealing with a very hardcore engineering concept, and then I may suddenly be able to link it with something completely different. For example, I can look at how a sketch/painting or music or humor is related to the concept that you are dealing with. If you are able to establish some kind of link, then you are actually (you can say in the language of the brain) improving the chances of retention of that knowledge. A mind map is promoted by many books, the software tools, and it was particularly by Buzon.

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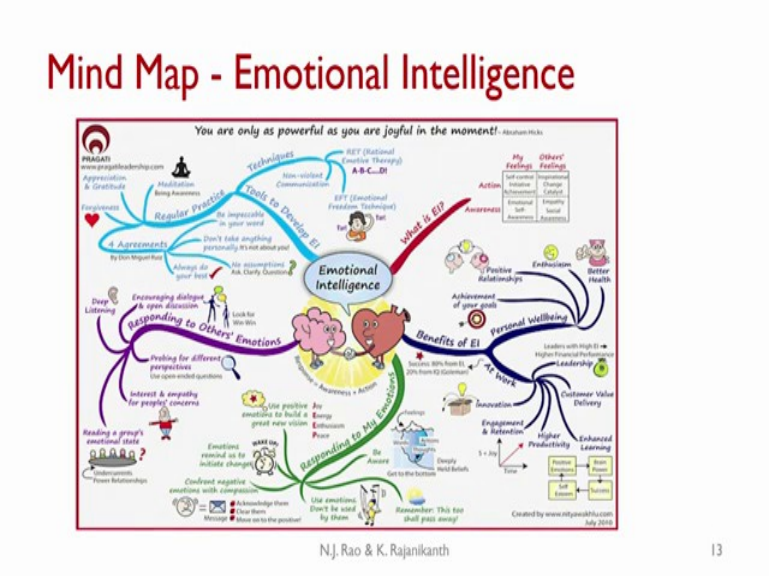

Shown here is a mind map of emotional intelligence. We had dealt with so-called emotional intelligence as part of the affective domain when we discussed it in Module 1. When we were looking at the three domains of learning that are cognitive, affective, and psychomotor domains - emotional intelligence is concerned with the affective domain.

Emotional intelligence is shown as to how two people or two persons are related and then you try to define 'what is emotional intelligence?' What are the benefits of emotional intelligence? One can draw the whole set of such diagrams. As we can see, it also looks like the axon and the dendrites kind of thing. One thing is, how do I respond to my own emotions, and how do I respond to the emotions of others. What are the tools and techniques that are available that can be used or to be developed for improving emotional intelligence?

Like that, you can keep on expanding, and we can create a beautiful diagram like this and make it your own - the way you represent will be unique. The teacher, by looking at the diagram and through discussion, can ensure that there are no errors, that means, you are not identifying something wrongly the way one is related to the other.

For example, consider enthusiasm or better health. If somebody says "better health-is related to emotional intelligence," one can debate that and if convinced that it is not an important issue, I can keep it, or I can reword that. I can also say good-health, as well as

bad-health, will also influence my emotional intelligence. So, one can modify the mind map.

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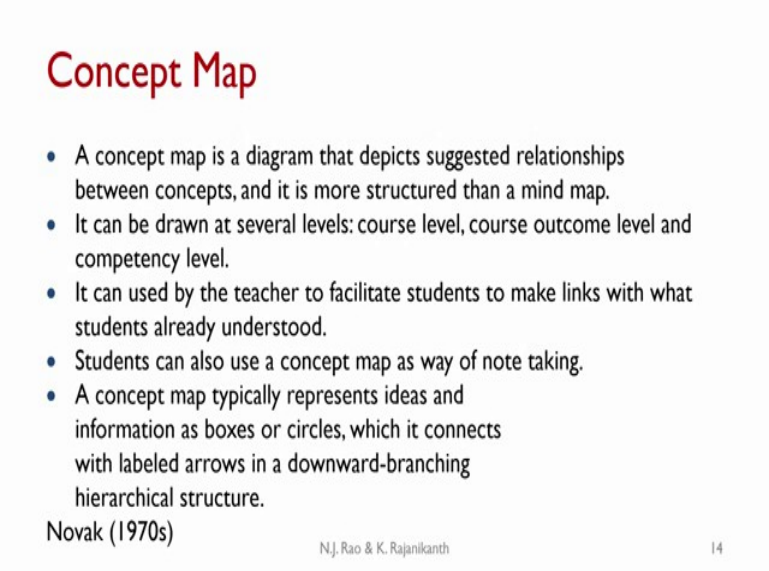

Similarly, let us look set another graphic organizer - concept map, which we have already seen in Module 2. A concept map is a diagram that depicts suggested relations between concepts, and it is more structured than a mind map.

As you can see, the mind map has a free format; you can just keep drawing the lines in whatever manner you want, whereas the concept map is well structured. There are more structured graphic representations that we will not be considering. The concept map can be drawn at several levels, course level, course outcome level, and competency level. It can be very detailed or minimal where only a small number of concepts are connected.

It can be used by a teacher to facilitate the students to make links with what students already understood. Let us say you are familiar with these concepts, and the concept that I am presently going to present is related to those you are familiar with. I can relate what the student already knew and take it forward by linking the new concepts to the previous concepts the students understood.

Students can also make use of a concept map as a way of note-taking. I can just draw a diagram with circles or squares representing concepts and keep connecting them using some linking phrases. As the teacher is presenting the information in the classroom, the

student can keep building a concept map on the side, his/her way of looking at it. Then the student can get it cross-checked by a peer or by the teacher. Then one concept is connected to the other using labeled arrows in a downward branching hierarchical structure. This was due to Novak and his associates, and right from the 1970s onwards, they have been promoting this in education as Cmap tools, and it can be downloaded free.

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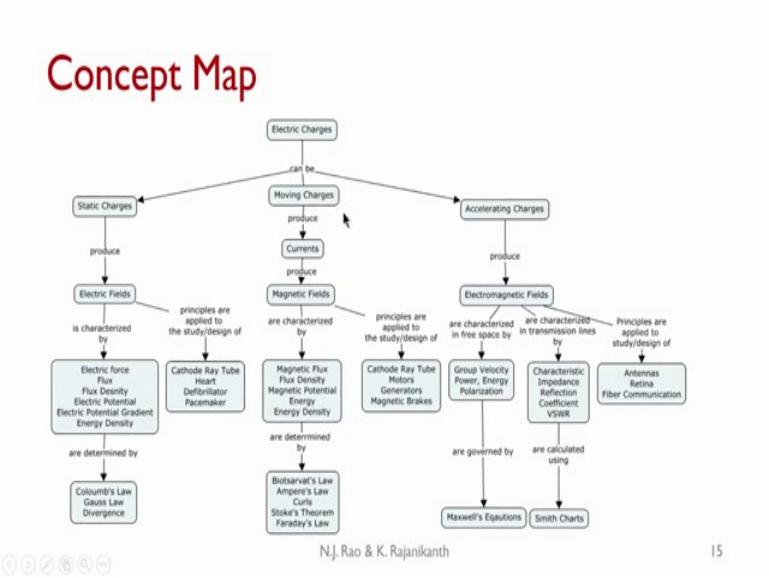

It is one of the very simple tools that one can quickly learn and use. Concept map shown here is a course on electromagnetics. What does electromagnetics deal with? They deal with electrical charges that can be static in nature, they can be moving at a constant velocity, or they may be accelerating. The static charges produce electric fields, from which I can keep on building. The electric field is characterized by the electric force, flux, flux density, electric potential, electric potential gradient, energy density, and so on.

These electric field principles are applied to study and design a cathode ray tube or defibrillator or pacemaker. The concept map is used as a way of designing the course. Finally, having designed this, you can present this course to students in this form. Once it is presented like this, the entire view of the course on electromagnetics is graphically imprinted in the minds of the students.

I consider the concept map of a course is a potent tool for designing, discussing with peers and presenting to the students. It can be used as also an effective tool to conduct a

course. There are three parts: static charges, moving charges and accelerating charges. We can write two or three-course outcomes for each type of electric charge. For each one, if we write three, I end up writing nine-course outcomes. They need not be evenly distributed.

Please note that in this concept map, we are not using one concept in a box. In that case, the map will just kind of grows unmanageable. But all the elements that are there inside a box are concepts. A box can be used to represent multiple concepts at the same level.

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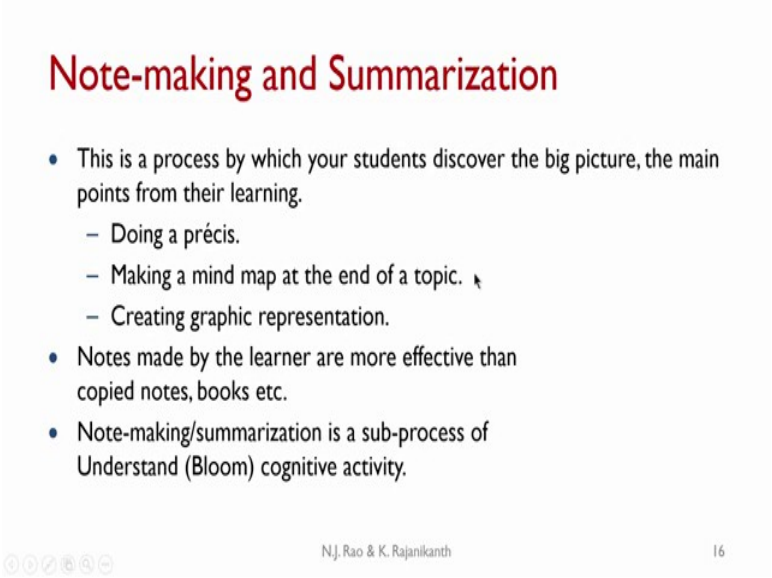

We have seen some graphic organizers, but I am sure one can come with (there are many things that are available on the internet, and one can make use of the appropriate graphic organizer for either as a part of instruction, as a part of the evaluation or a kind of part a tool that can be used by student to explore his understanding.) We come to another issue where the student is involved, mainly 'note-making and summarization.' This is the process by which your students discover the bigger picture by capturing the main points from their learning. Either you do a précis, making a mind map at the end of a topic, or creating a graphic representation, notes made by the learners are more effective than copied notes or books.

For example, the teacher can write on the board or project some information. If the student writes that back into his/her own notes, and that is not note-making. The student needs to write a summary of the way he has understood the topic. If you recall in Module

1, we looked at the cognitive levels, where we talked about six cognitive levels, and note-making and summarization is a sub-process of the cognitive process ‘understand’ as per Bloom's cognitive levels. Note making and summarization are quite effective, and it can be readily used in all contexts.

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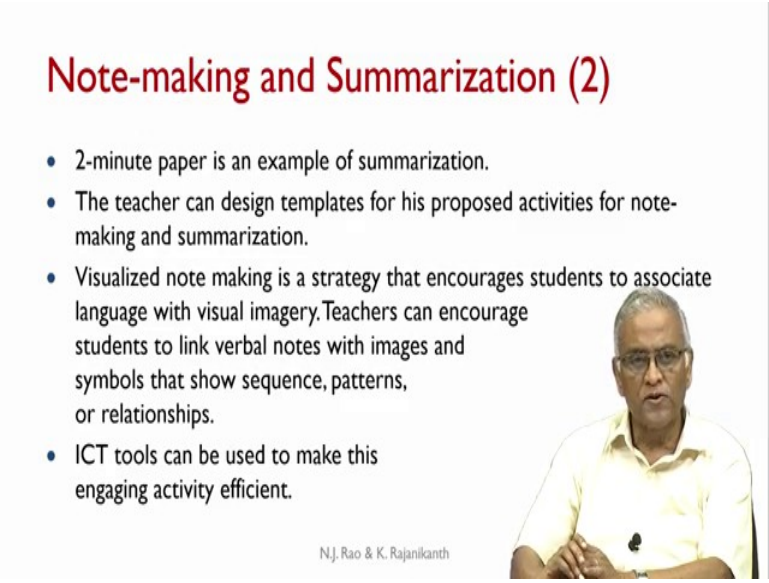

For example, there is one instructional component - a 2-minute paper is an example of summarization. The instructor can ask all the students to write for 2 minutes a paper. You can effectively use Google docs to collect all the 2-minute papers written by the students, and by reviewing them, you will be able to give concrete feedback to the students.

A teacher can design a template for his proposed activities for note-making and summarization. He can create a simple table or some kind of a chart and ask students to fill it up. Another one is visualized note-making, a method that encourages students to associate language with visual imagery. This can be very powerful. Teachers can encourage students to link verbal notes with images and symbols that show sequence, patterns, or relationships.

For all these once again, ICT tools can be used to make this very engaging activity efficient. If the students require a lot of time to do any of these things, obviously, you cannot use them frequently. These days one can assume that all students have

smartphones or laptops, and if the teacher is familiar with the required ICT tool, it is possible to use these instructional components.

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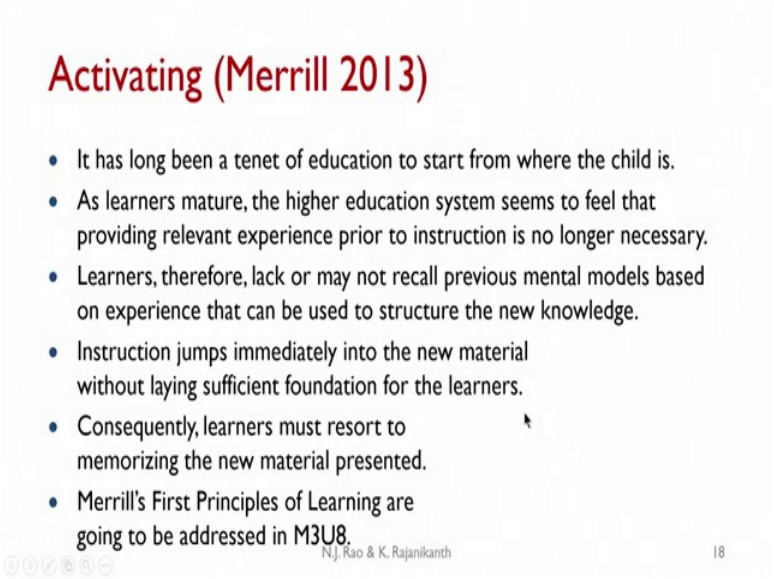

Another instruction component is 'activating.' This is not anything new. It has long been a tenet of education to start where the child is. It was mainly used in school education. If you look at the internet, there is a tremendous amount of literature related to activation or activating, but all the examples will mostly belong to school education. Somehow as learners mature, the higher education system seems to feel that providing relevant experience prior to instruction is no longer necessary, and that has become good.

Because the activity is not integral to any of the existing practices of instruction in higher education, activating is not used by the majority of the faculty at present; learners lack or may not recall previous mental models based on experience that can be used to structure the new knowledge. One of the things we always said is we take new knowledge, process it in the working memory, and then try to link it with what we already knew.

What we already knew how to link it is a major activity. To that extent, you need to find out which are the things to which you can link, and that is the process of activation. If you jump to an entirely new concept, the only thing that the student can do is only rote learning; just remember and reproduce. So, you need to go through the process of linking the new knowledge to what students already knew. This has been converted into a principle of learning, which will be explored in the following unit, M3U8. Merrill's first

principles of learning are going to be addressed - one of the principles is the activation of prior knowledge (will be explored in the next unit.)

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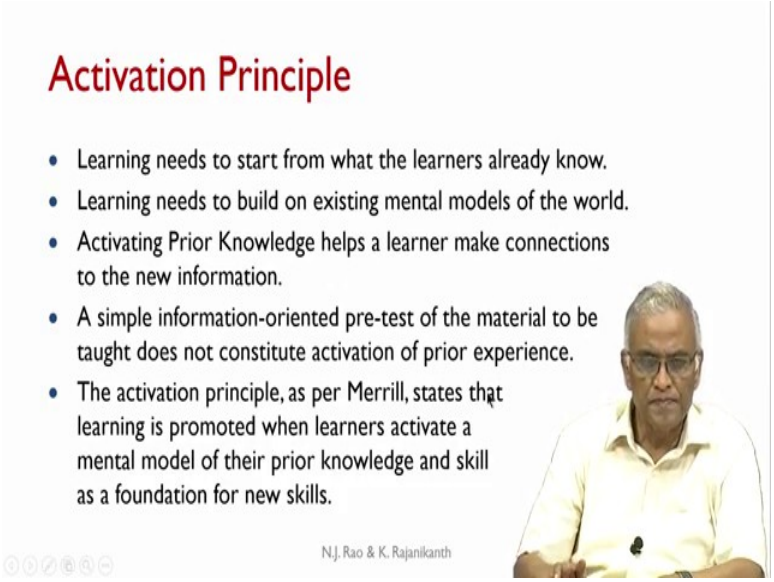

Let us look at it a little more about the activation principle. Learning needs to start from what the learners already knew; it is a simple statement. Learning needs to build on existing mental models of the world. While it is so, but we usually do not, and that is where the activation of prior knowledge helps a learner make connections to the new information. One of the things that people do is conduct a pretest or quiz to find out what the students know about the topic that we are going to present.

But that kind of thing does not fully constitute the activation of prior knowledge. The activation principle, as per Merrill, states that ‘learning is promoted when learners activate a prior mental model of their prior knowledge and skill as a foundation for new skills.’

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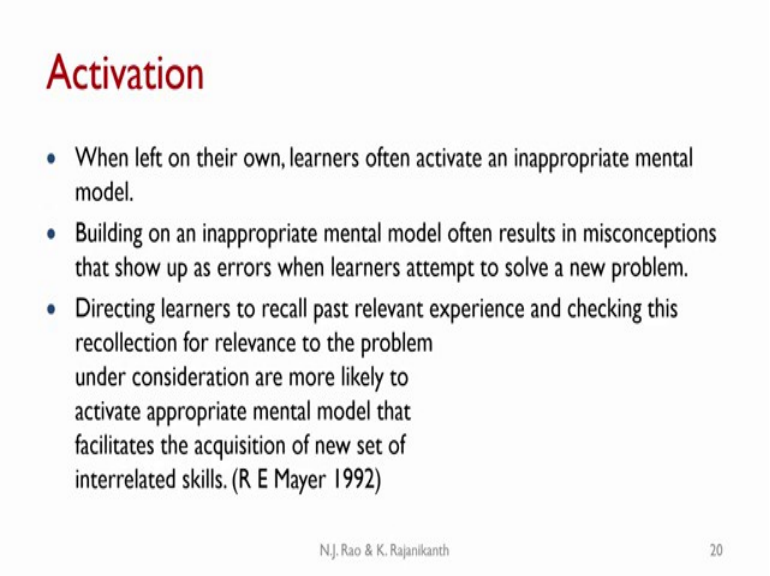

If you do not do this, what happens? When left on their own, learners often activate an inappropriate mental model, because as we said, the learning constitutes somehow connecting the new knowledge to something that you already know. But if you do not go through a guided experience in this, there is a possibility that you connect it to the wrong neural network. Building an appropriate mental model often results in misconceptions that show up as errors where learners attempt to solve a new problem. This often happens. You must have seen any number of examples, even in Newton's laws of motion, how people have accumulated some misconceptions about even some simple things.

Directing learners to recall past relevant experience and checking this collection for relevance to the problem under consideration is more likely to activate an appropriate mental model that facilitates the acquisition of a new set of interrelated skills. This is the way of saying about the purpose of activation and the process of activation.

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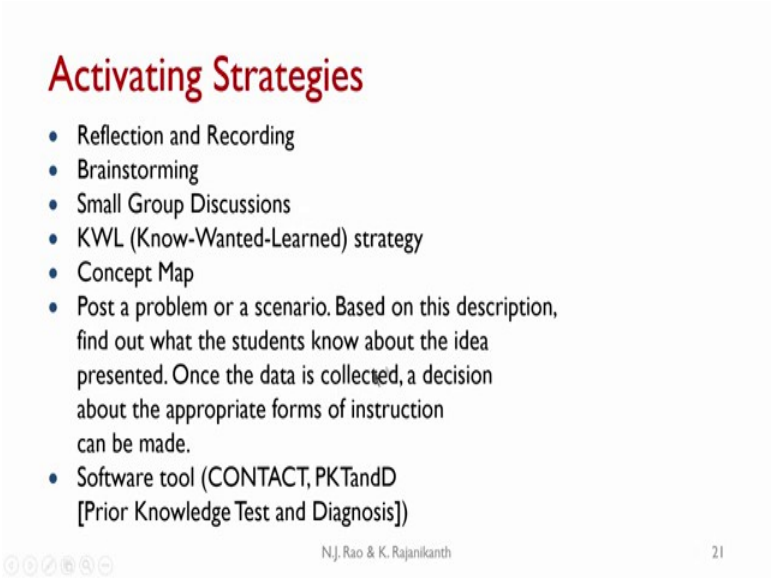

Some of the activating strategies: reflection and recording, brainstorming, small group discussion, KWL (know-wanted-learned) strategy. Create a simple table with three columns, with column headings, ‘what you know,’ ‘what you wanted to know’ and ‘what you have learned’ then start writing into that. One can use concept maps, post a problem, or a scenario. Based on this description, find out what the students know about the idea presented. Once the data is collected, a decision about the appropriate forms of instruction can be made.

So, here is an interactive process; you present a problem and ask the students to respond. Whatever they say, you write on the board or type out so that it comes on the screen. Once the data is collected, then you can see if there are wrong concepts or concepts that are irrelevant; they can be together discussed and improve the collected data.

For example, there are some software tools called CONTACT, or PKTandD (Prior Knowledge Test and Diagnosis,) or one can even create a simple software tool to perform this activation. It does not mean that a teacher has to reuse all of them. They can use what they feel comfortable with or what they consider appropriate to their particular topic and context.

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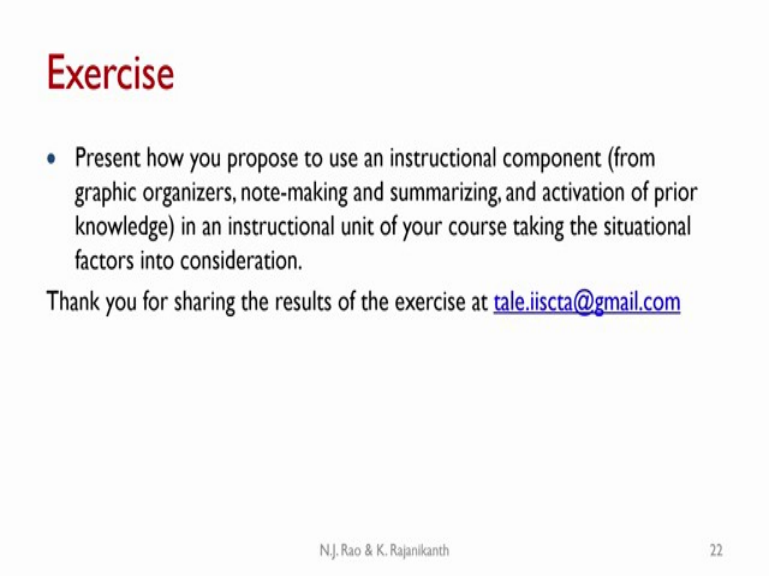

Exercise: present how you propose to use an instructional component (from any of these three - graphic organizers, note-making and summarizing, and activation of prior knowledge) in an instructional unit of your course taking the situational factors into consideration.

If you have already used, you can report that or propose on your own (if you have not used), how do you use a graphic organizer, how do you use the activity of note making and summarizing or activation of prior knowledge. Thank you for sharing the results of the exercise at this particular email ID tale.iiscta@gmail.com.

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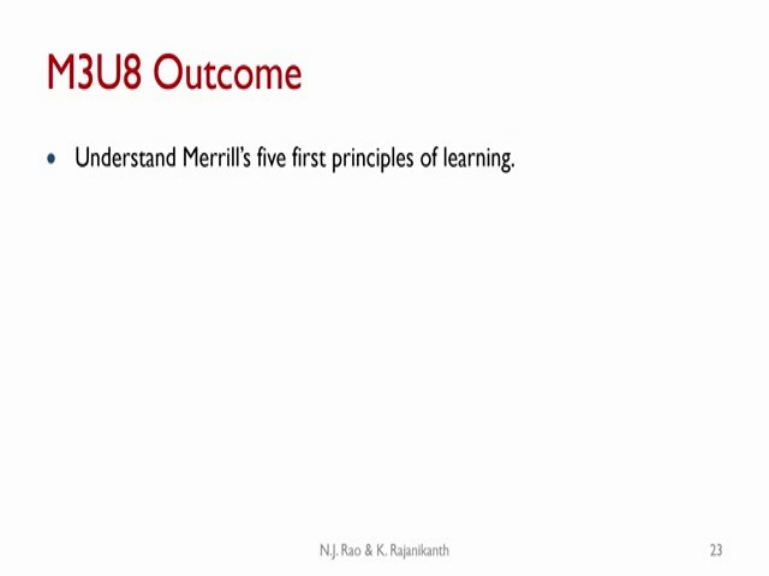

In the next unit, we will be looking at Merrill's five first principles of learning. These principles of learning are trying to state, 'if you follow these principles, the students are likely to learn better.' The extent of the effectiveness of learning will depend on the extent to which you have used these principles.

Thank you for your attention.