TALE - 2 Course Design and Instruction of Engineering Courses

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Lecture – 34
Instruction for Metacognitive Learning

Greetings and welcome to TALE module 3 unit 16 on Instruction for Metacognition.

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In the earlier unit, we understood the instruction for design. In this unit, which is entirely different from the previous topic, we aim at understanding the need for and methods of instruction for metacognitive learning.

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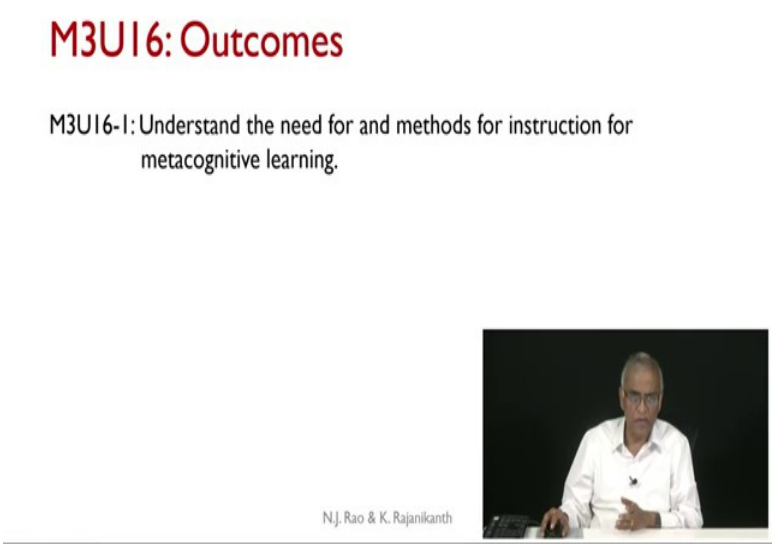

This area of metacognitive learning is somewhat new to the majority of the faculty. It requires some amount of spending time in understanding the terminology, its role, and what is to be done about it. But once we understand that we will be able to appreciate the central role that metacognitive learning plays.

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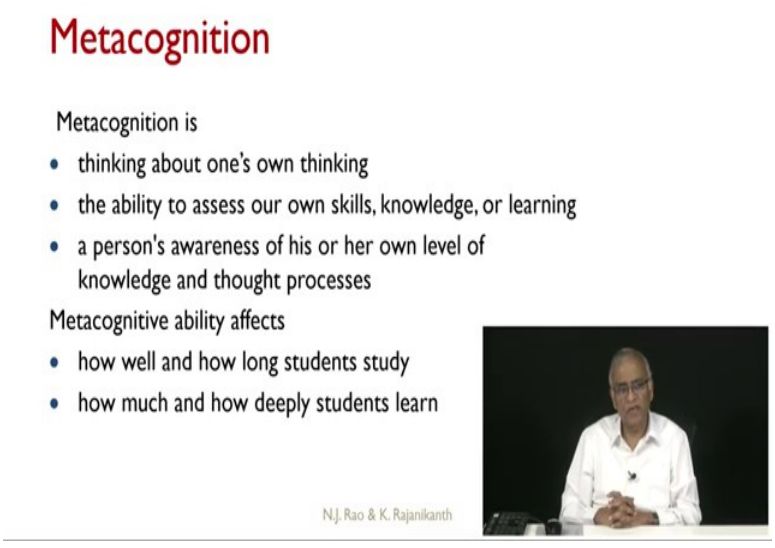

We talked about metacognition in TALE Module 1 when we were talking about the taxonomy of learning. Metacognitive knowledge is one of the knowledge categories as per Anderson Bloom's taxonomy.

Metacognition is thinking about one's own thinking (as mentioned earlier.) It is the ability to assess our own skills, knowledge, or learning. Do I understand what is it that I can do or what is it that I know or whether I am learning or not, whether I have learned or not? It is also a person's awareness of his or her own level of knowledge and thought process.

Obviously, based on our own metacognition, that ability affects how well and how long students study. For example, if I already know that I know the particular topic very well, I will not spend time on that, but if I know that I do not seem to understand completely, then I will spend more time on that particular topic. The amount of time I spend on learning a particular topic will obviously depend on my metacognitive knowledge.

It influences how much and how deeply the students learn. For example, I can superficially learn and claim to myself that I have learned. I realize only when some questions need to be answered; my learning was not adequate. The metacognitive ability affects how well and how long students study, how much, and how deeply the students learn.

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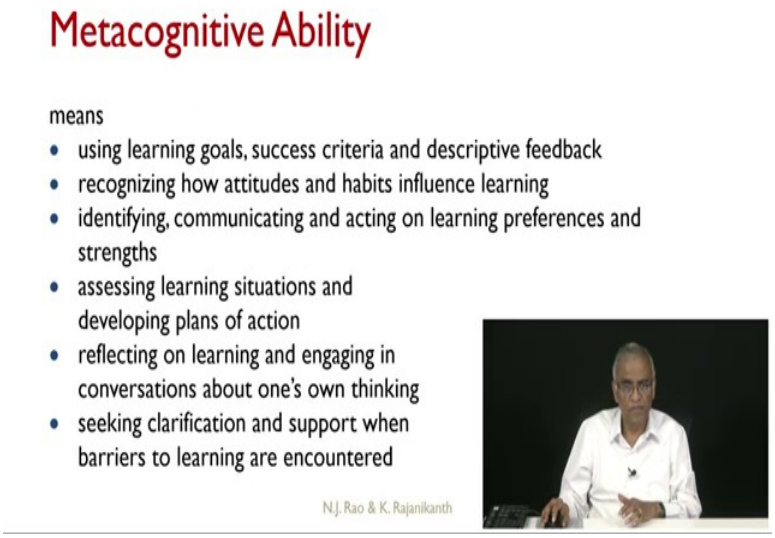

How does it get translated? All these get translated into the day to day activity either for the teacher or for the student. Metacognitive ability means using learning goals, success criteria, and descriptive feedback. All the terms are unambiguous; that means, do I use;

or how do I use my learning goals? How do I use my success criteria, and also how do I understand the descriptive feedback given to me?

Recognizing how attitudes and habits influence learning; identifying, communicating and acting and learning preferences and strengths; assessing learning situations and developing plans of action; reflecting on learning and engage in conversation about one's own thinking.

I think this is one skill that everyone should develop; reflecting on learning; that means, how did I learn, what is the process that I have gone through and where did I find difficulty, how am I judging my learning and with regard to that I must be able to engage in conversation with somebody else also about my own thinking.

The more we do that, the more metacognitive ability that we will get. Sometimes we do not fully understand something; that is when we should seek clarification and support when barriers to learning are encountered. If you are able to do all these things in your day to day a learning activity, or even teaching activity, then we have the metacognitive ability.

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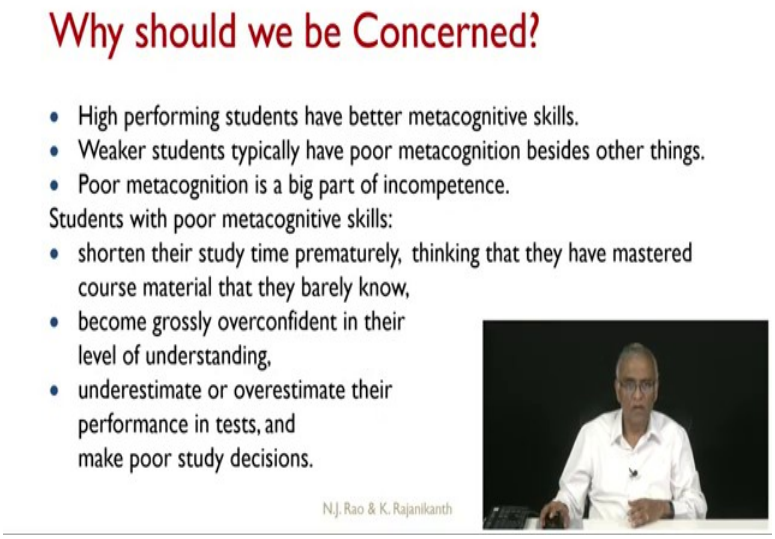

Why should we be concerned about the metacognitive ability or metacognitive activities? It is quite known high performing students have good metacognitive skills. In high-end institutes like IITs, NITs; where the students are selected through a very elaborate

process, they are high performing students, and they implicitly have better metacognitive skills.

In an IIT/NIT, if the teacher does not spend much time on metacognitive instruction because the majority of students already have that skill. But weaker students have poor metacognition besides other things. This is where about 90% of engineering colleges have a significant percentage of weaker students. Their learning is influenced by their poor metacognition abilities.

It can be said that poor metacognition is a big part of incompetence. If weak students enter higher education institutions and one of the elements of their weakness is their poor metacognition. For example, students with poor metacognition skills shorten their study time. They read for little time and think they have understood, and they will not continue, thinking that they have mastered course material which they barely know, or become grossly overconfident in the level of understanding, or underestimate or overestimate their performance in tests and make poor study decisions.

If you ask a poor metacognitive student after the test, he may feel very confident that he has aced the entire paper, or will just declare that he did not do anything well. So, he is not able to realistically estimate his performance, and because of that, they make wrong post-test study decisions on how much to study, when to study, what to study.

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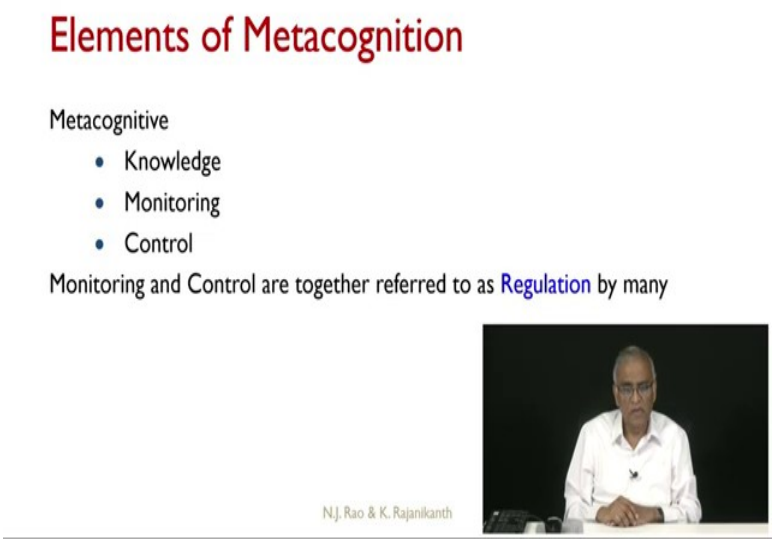

Now, we look at the elements of metacognition. The three elements are metacognitive knowledge, metacognitive monitoring, and metacognitive control. And in the literature, monitoring and control are together referred to as metacognitive regulation. Even today, many research papers do not differentiate, do not separate monitoring and control, whereas, in some parts, monitoring is a separate process, and controlling is a separate process.

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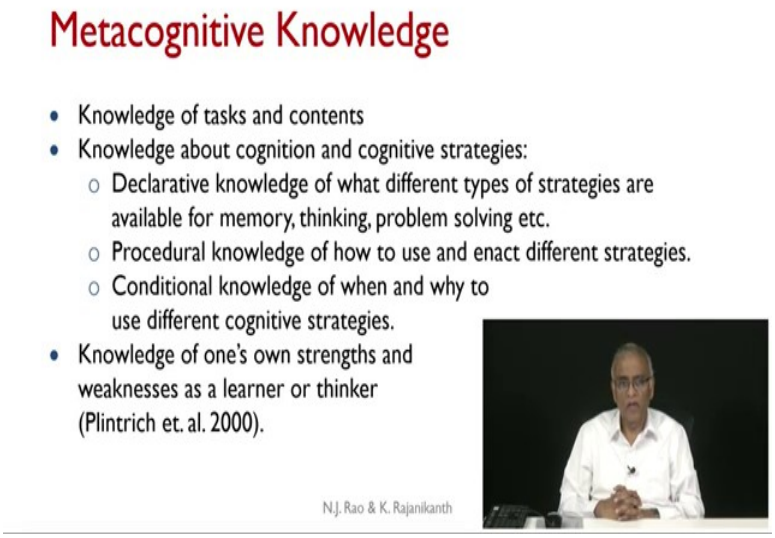

Metacognitive knowledge: do you have the knowledge of tasks and the content? Do you understand the task? Do you know what is to be done? Do you understand the contents that are presented to you? That is the knowledge of the tasks.

The other one is knowledge about cognition and cognitive strategies. For example, metacognitive knowledge is considered to be declarative knowledge and procedural knowledge. What strategies are available for memory, thinking, and problem-solving. Because these are the three activities, a student is likely to be dominantly involved. That means, what strategy do I know, what strategies I have for transferring from temporary memory to long-term memory, what are all the strategies that I have, do I know of those strategies?

Similarly, for thinking and problem-solving. Am I aware of these strategies? Similarly, this knowledge refers to procedural knowledge, that is how to use and enact different

strategies, and conditional knowledge is when and why to use different cognitive strategies?

As you can see, knowledge about cognitive strategies; these are the ones that are available, and I need to be aware of it first. If I do not know any of these things, I have not read about it obviously. This is the third aspect of metacognitive knowledge; do I know my own strengths and weaknesses as a learner? This classification or this elaboration of metacognitive knowledge is through Plintrich et.al.

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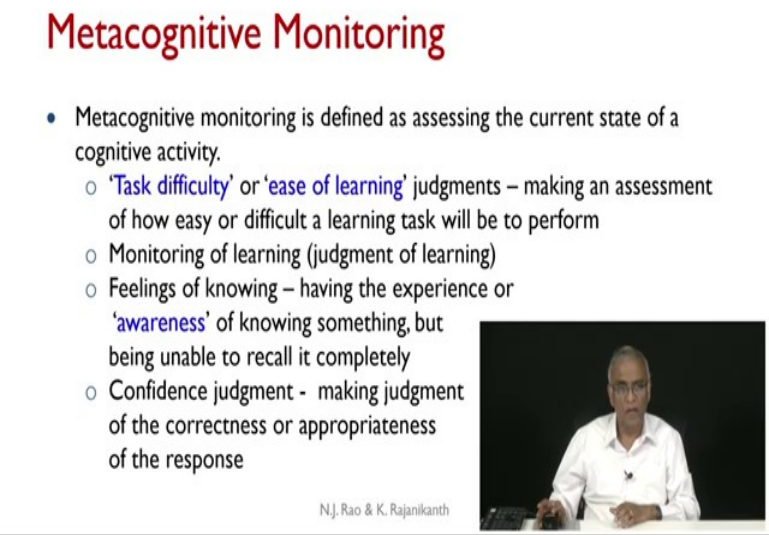

Metacognitive monitoring: I should be able to observe what is happening. Metacognitive monitoring is defined as assessing the current state of cognitive activity. This consists of task difficulty or ease of learning judgments; that means I am making a judgment, making an assessment of how easy or difficult a learning skill will be to perform.

Through monitoring, I should be able to make an assessment of how easy or difficult a learning task will be to perform. Monitoring of learning means making a judgment to what extent one has learned that a particular topic, how far one needs to go? “This is where I am with respect to learning a particular topic” is monitoring.

Also, I should be able to monitor the feelings of knowing, for example, having the experience of awareness of knowing something, but being unable to recall it completely. This kind of feeling of knowing is also part of monitoring. The next one is confidence

judgment, making judgments of the correctness or appropriateness of the response. For example, if I have responded to something, am I able to make a judgment whether I have done it correctly or not? That means if I made a judgment that is our correct, then my confidence in my ability to judge will increase. So these are the four elements of metacognitive monitoring.

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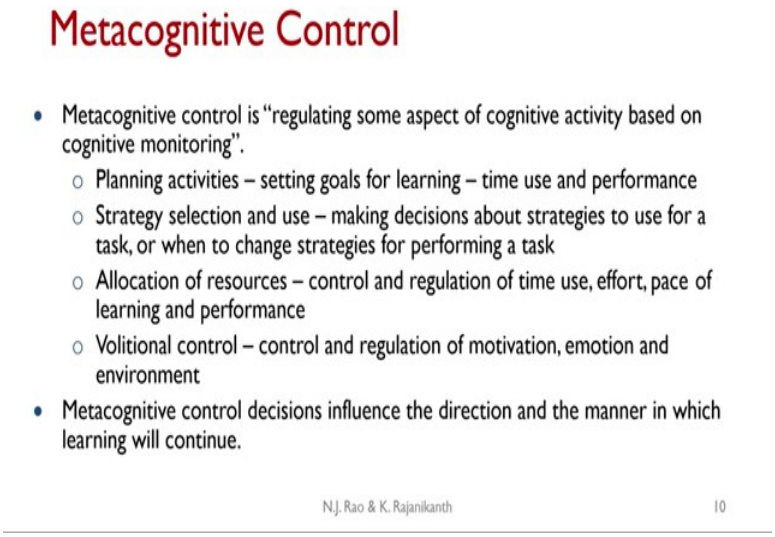

Metacognitive control: we should be able to regulate some aspects of our cognitive activity based on metacognitive monitoring. What aspect are we regulating? One is planning activities; planning activity means I should be able to set goals for learning, time use, and performance. I set the goals: by such and such time by tomorrow, I should be able to prepare a set of slides for this topic and how much time do I generally require and how well I am going to do that.

Strategy selection and use: making decisions about strategies to use for a task, or when to change strategies for performing a task. Not only you are setting goals, but you are making decisions about strategies and also under what conditions you will be changing the strategy should also be known.

How do you allocate resources for control, regulation of time use, effort, the pace of learning, and performance? Volitional control - control and regulation of motivation, emotion, and environment. Because when we are working, we may not have that much control over the environment. Let us say it is very noisy - I need to control that; I am

feeling negative about something - I should be able to regulate or control my emotions as well as motivations.

Metacognitive control decisions influence the direction and the manner in which learning will continue. Most of the times, we will be doing all these four activities, but without being fully aware of it. Or we may not be able to perform these activities properly because we are not aware of them or we do not know. For example, we can not easily monitor ourselves appropriately.

Once people/students are trained in doing these a few times, then it starts becoming second nature. But if somebody is poor in metacognition, he needs to undergo this experience several times until he picks up the required skill.

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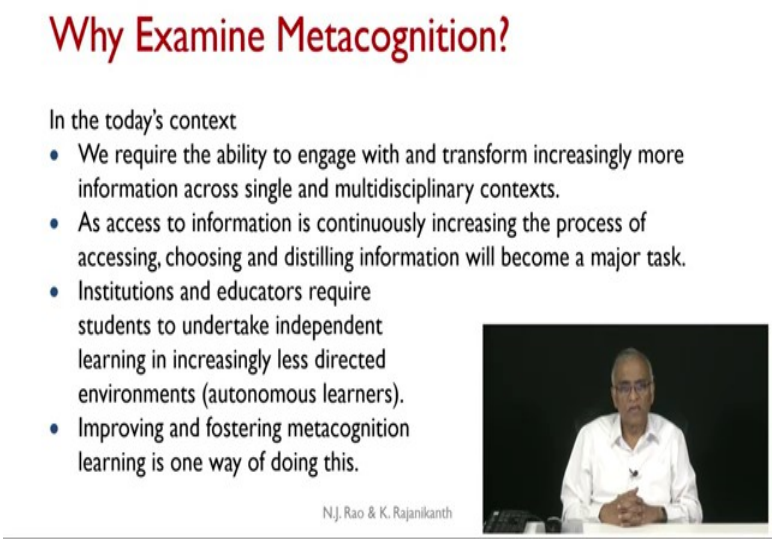

We can consider why we want to examine metacognition? In today's context, we require the ability to engage with and transform more information increasingly across a single or multidisciplinary context. Everything that we need to know cannot be pushed into a formal curriculum; depending on the task that you are working on, you may want to continually access new information which is available today on the internet or is readily accessible.

One should be able to engage with a lot of information across a single discipline or multidisciplinary context. Also, as access to information is continuously increasing, the

process of accessing, choosing and distilling information will become a significant task. Sometimes when you Google, you get an endless amount of information. You cannot waste your time in trying to read everything and distill information from that.

One of the skills that you require is a metacognitive skill of distilling information. These days institutional educators require students to undertake independent learning in increasingly less directed environments or as autonomous learners. Anything and everything cannot be taught in the classroom using a chalkboard or a projector; some things are touched briefly, or overviews are presented, and the students have to work out the details.

Every detail is unlikely to be presented in today's classrooms. One has to become an autonomous learner - a good autonomous learner is also a good metacognitive person. To achieve these three, that is the ability to engage with increasingly more information or distill information or to become an autonomous learner; one of the best methods is fostering metacognition/metacognition learning.

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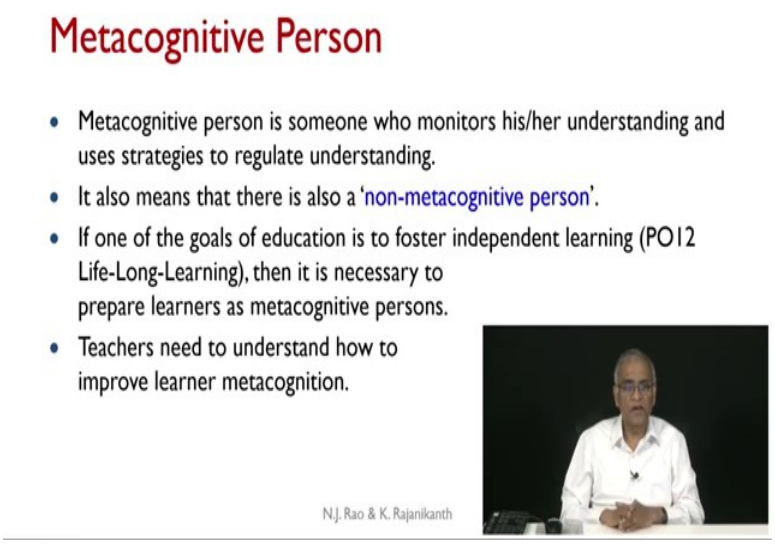

Who is a metacognitive person? A metacognitive person is someone who monitors his or her understanding and uses strategies to regulate understanding. One is monitoring, and the other one is using strategies to regulate understanding. It also means there is also a non-metacognitive person.

One of the goals of engineering education is to foster independent learning, which is stated as Program Outcome 12 called lifelong learning. If you want to attain PO 12 through your engineering program, it is necessary to prepare learners as metacognitive persons. You cannot promote/establish that my, a student is a lifelong learner. The main route is making him a metacognitive person, and because of that, teachers need to understand how to improve learners' metacognition.

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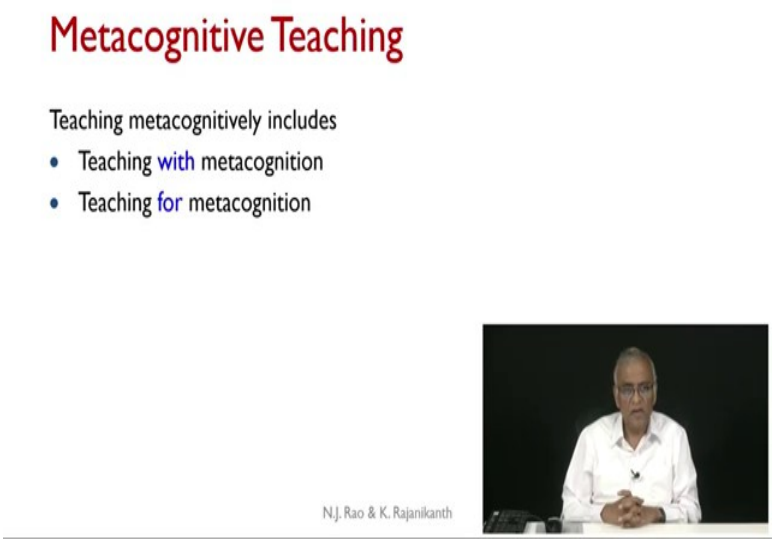

Metacognitive teaching: teaching metacognitively includes teaching 'with' metacognition and teaching 'for' metacognition; the first one is related to the teacher, and the second one is related to instruction.

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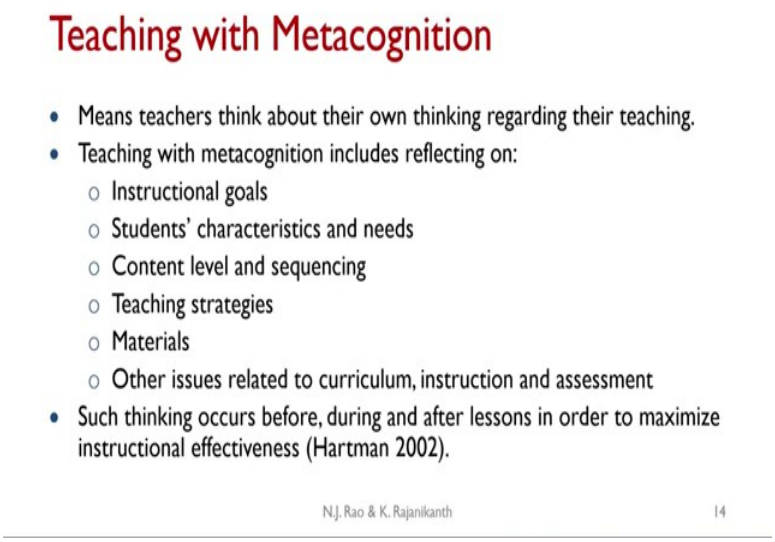

Teaching with metacognition means teachers are thinking about their own teaching.

Teaching with metacognition includes reflecting on instructional goals; that means, the teacher should be very clear about what are the instructional goals, implications. It is not mere repetition; you must really understand the depth of the instruction goal or the at what level it has to be done, how important it is, how it is related to other instructional goals, and so on. Also, you should be able to reflect on students' characteristics and needs.

As we said, students in all institutions are not the same; so, each group of students has their own characteristics and needs. Content level and sequencing of all courses are not the same; teaching strategies that you want to use the materials that are available to you and other issues related to curriculum instruction and assessment.

Teaching with metacognition requires reflecting on all these issues. Again watch out it is a continuous process. Such thinking occurs; before, during, and after lessons in order to maximize instructional effectiveness.

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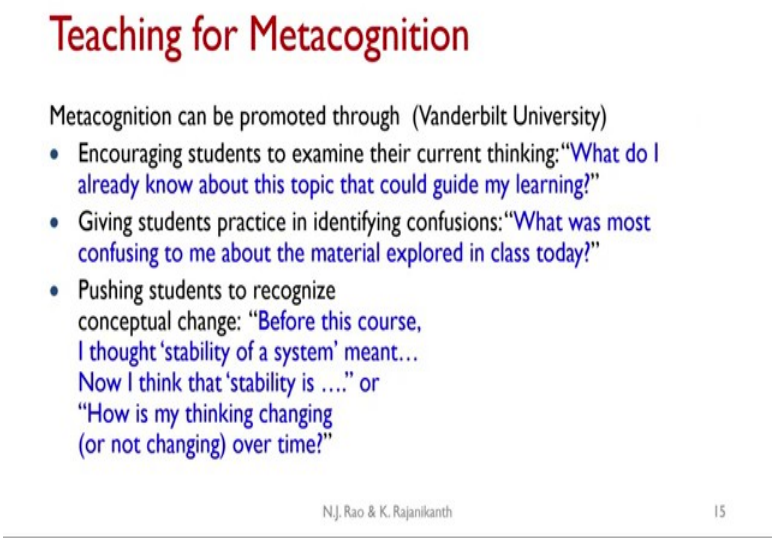

Teaching for metacognition: metacognition can be promoted through: (note that some of the universities on their websites, they take a position with respect to many of the pedagogical issues, and they keep some material for ready reference by the faculty of any particular branch - I am just quoting from Vanderbilt University) encouraging students to examine their current thinking; that is what do I already know about this topic that could guide my learning?

Giving students practice in identifying confusion - sometimes a statement may be confusing to the student. But the student should be able to articulate what was most confusing to me about the material explored in the class today. Something I have listened to in the class, but it was confusing; at what point it started becoming confusing and will the student be able to identify. Or pushing students to recognize the conceptual change, for example, before this course I thought the stability of a system meant such and such. Now, I think stability is such and such.

When a conceptual change has occurred, the student should be able to write prior to instruction; this was his opinion, or this was his understanding. But after learning this is how the understanding changed. He should vocalize or sometimes write it on a piece of paper, and if he does a few times it makes a tremendous difference to his way of thinking. You are keeping track of how your thinking is changing over time, and this awareness of the changing in a conscious way makes you a metacognitive person.

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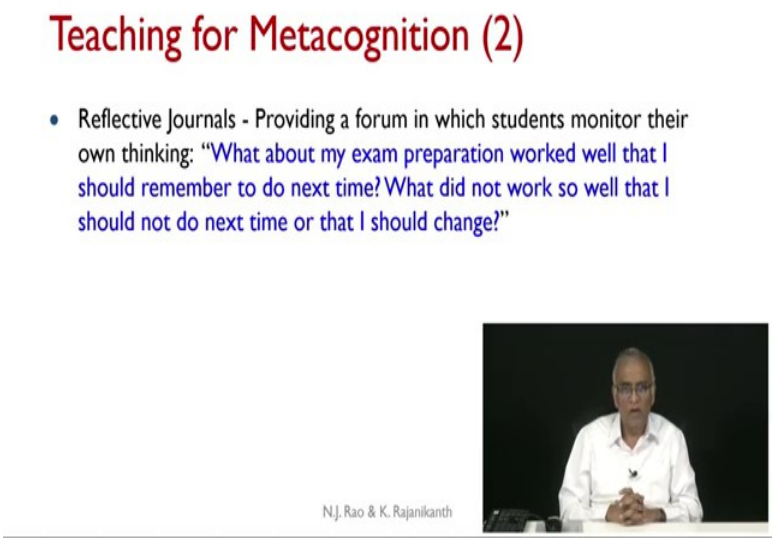

Further, one of the tools is reflective journals, providing a forum in which students monitor their own thinking. You ask your students to write their own journal; what about my exam preparation; preparation worked well that I should remember it to do next time.

Let us say I did something right; can I note it down just to make sure that I can use that next time. If something did not work so well, and I should not again waste my time doing or using that particular method. The teacher can encourage a student to maintain a reflective journal in which the student reflects on what he/she has done. It is only for the eyes of the student rather than for anyone to make judgement on that.

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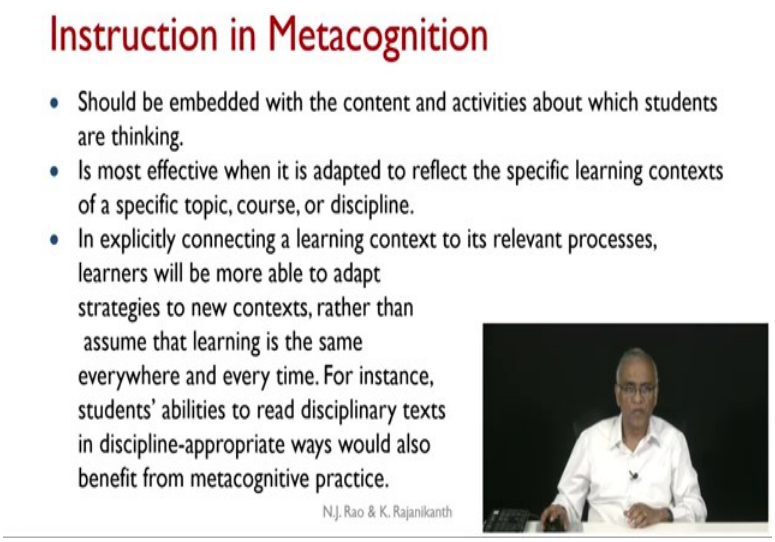

Instruction in metacognition should be embedded with the content and activities about which students are thinking. It is most effective when it is adapted to reflect the specific learning context or specific topic, course, or discipline. What it means; the instruction and metacognition should not be general; it should be done in the context of a specific course or a specific course.

In explicitly connecting a learning context to its relevant processes, learners will be able to adopt strategies to new contexts rather than assume that learning is the same everywhere and every time. For instance, students' ability to read disciplinary texts in discipline-appropriate ways would also benefit from the metacognitive practice.

The way instruction should take place is with respect to a specific course, and once you have learned that that learning is becoming generic, that means, if I can become a metacognitive person, then I will be able to apply that to other contexts as well.

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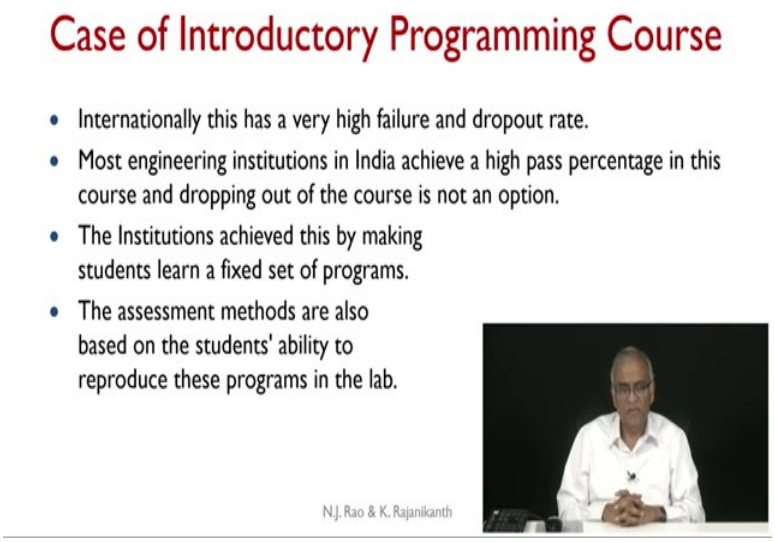

Let us take the case introductory programming course. Internationally this has a very high failure and dropout rate, and it has been known. In India, most engineering institutes achieve a high pass percentage in this course, and dropping out of the course is not an option because it is compulsory.

How did the institutions achieve this? By making students learn a fixed set of programs, not programming. The system somehow adapted itself to achieving high pass percentages by converting the course into learning a fixed set of programs.

The assessment methods are also based on the student's ability to reproduce these programs in the lab. That means there is a fixed set of programs 20 or 25, and the teacher presents these programs; only one code presented on the board. And the student should be able to remember and reproduce that code and run it in the laboratory. Generally, you are not supposed to change the code, even if he can write more efficient code.

Somehow system adjusts to making the students learn a fixed set of programs, hoping that they would be able to code for new problems.

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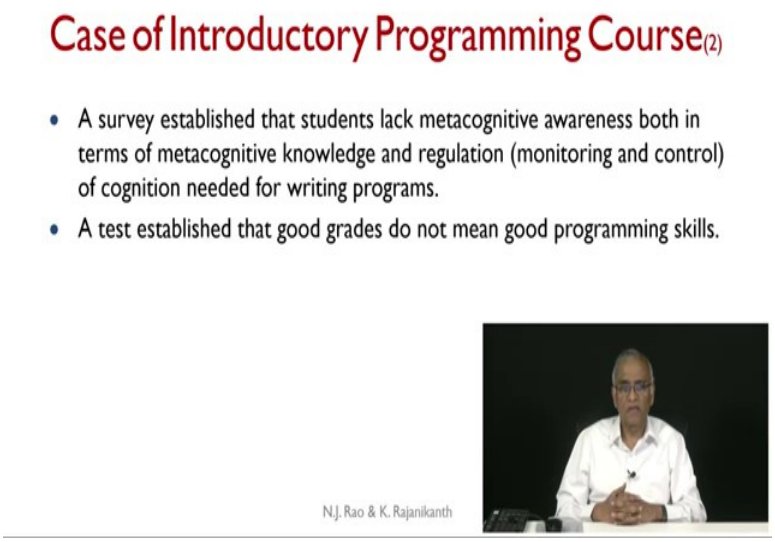

A survey established that students lack metacognitive awareness both in terms of metacognitive knowledge and regulation (monitoring and control) of cognition needed for writing programs. Also, another survey established that good grades do not mean good programming skills; even if somebody got 'A' or 'S", it does not mean that he/she is capable of programming.

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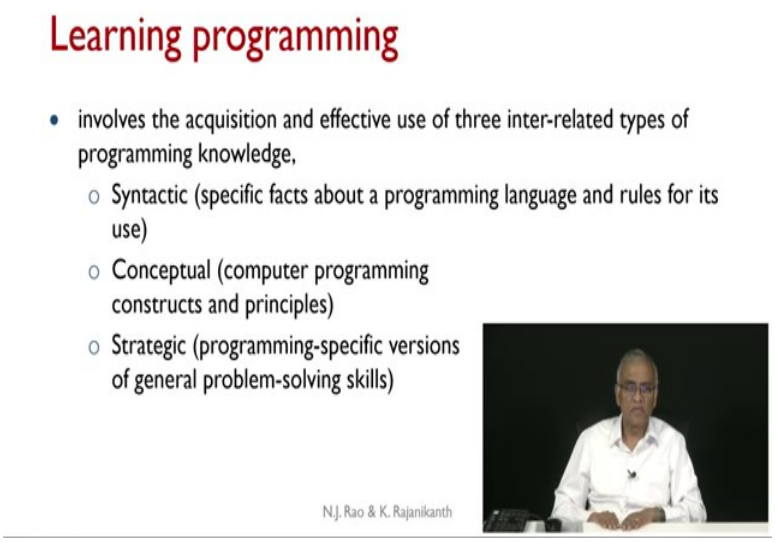

There is some issue with regard to this particular course itself. Learning programming involves the acquisition and effective use of three interrelated types of programming

knowledge. What are these? One is syntactic, specific facts about programming language and rules for its use; this is what generally presented in the class

Conceptual (computer programming constructs and principles): how do I really create an algorithm base and interpret the problem from that. Strategy: programming-specific versions of general program solving skills.

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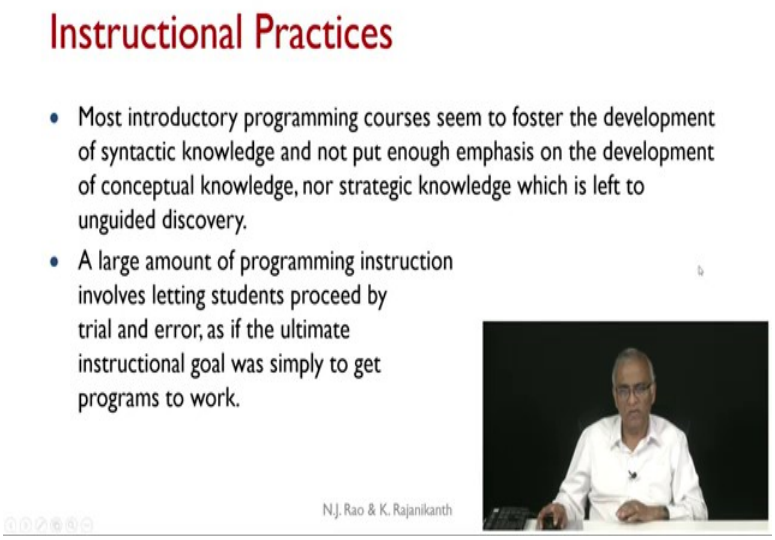

Most of the introductory programming courses seem to foster the development of syntactic knowledge and not put enough emphasis on the development of conceptual knowledge nor strategic knowledge, which is left to unguided discovery. When it is not explicitly dealt with in the classroom, then the students will have to discover by themselves, and no one is guiding that process.

Metacognitive instruction of programming involves letting students proceed by trial and error. The ultimate instructional goal in many institutions appears to get the programs to work.

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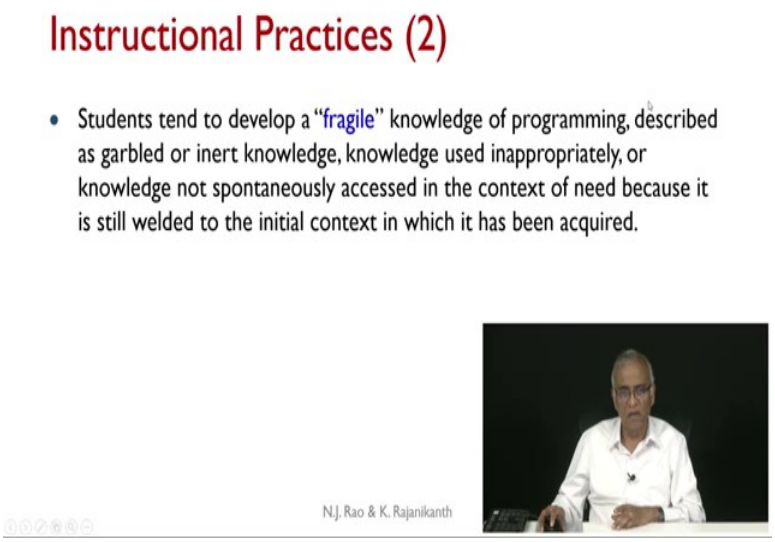

What is the consequence? Students tend to develop a fragile knowledge of programming described as garbled or inert knowledge; that means, you know a set of programs. It translates like this - out of the 20 standard programs, there is one program to find the area of a rectangle. If you ask the students to find the area of a triangle, almost 90 percent of the students seem to be failing.

That means, they have inert knowledge, but they are not able to appropriately understand the new context and slightly alter the code. They use their knowledge inappropriately. They cannot alter the code appropriately because their knowledge is still welded to the initial context in which it has been acquired. Students are only familiar with one context, and they are not able to adapt to the changing context.

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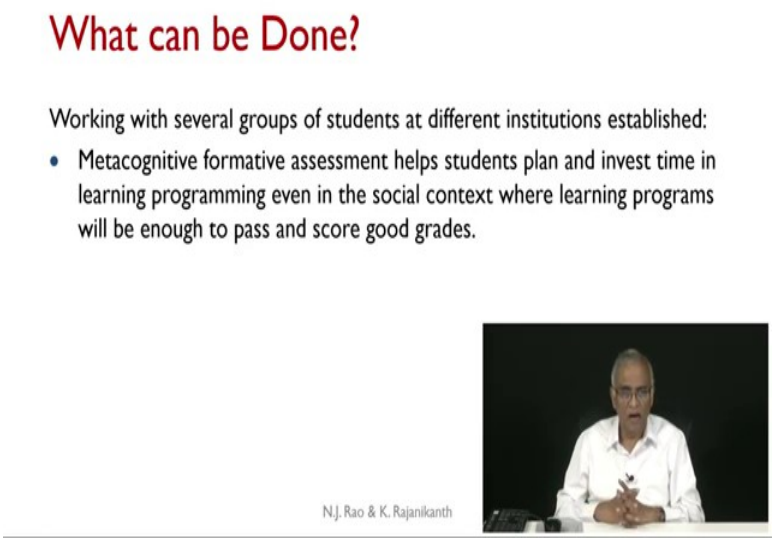

What can be done? Working with several groups of students at different institutions established metacognitive formative assessment helps students plan and invest time in learning programming even in the social context where learning programs will be enough to pass and score good grades.

As you can see, it is a significant barrier; that means if I only learn programs I can get good grades. There is not much motivation for majority of the students participating in any metacognitive formative assessment. A small number of students were serious about learning programming, and they participated in this kind of exercise. But it should be done as a matter of routine.

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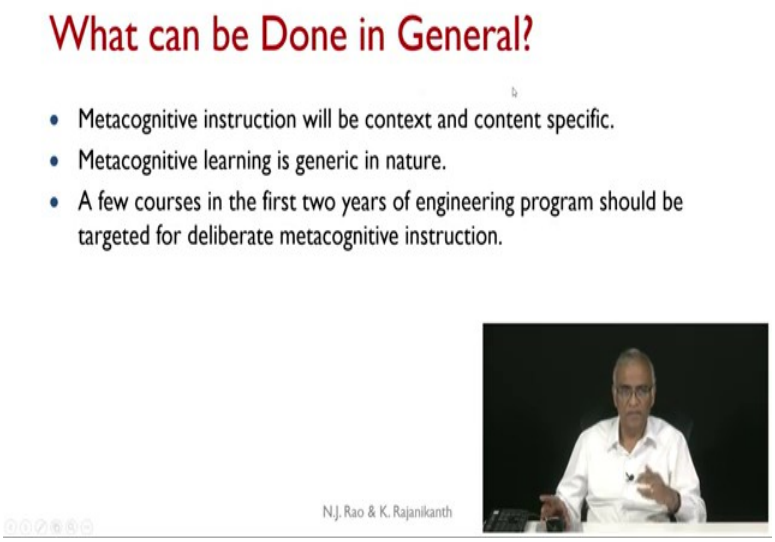

In general, what can be done about metacognitive instruction? The first thing is metacognitive instruction should be context and content-specific, but the metacognitive learning is generic in nature. So, what should we do? A few courses in the first two years of engineering program should be targeted for a deliberate metacognitive instruction.

How do we choose these courses? You can take a mathematics course/programming course/descriptive course/engineering science course or even an English course; a few (5-6) courses can be targeted; that means, the instructors for those courses should be trained to include metacognitive instruction deliberately.

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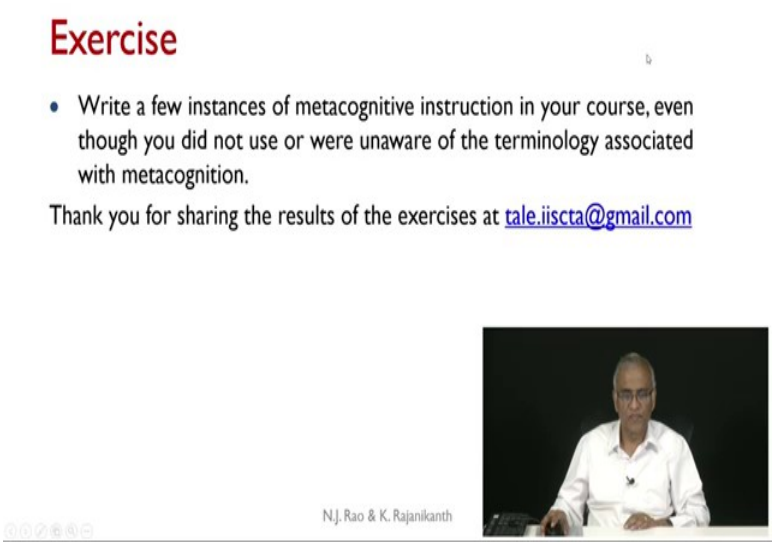

We request you to write a few instances of metacognitive instruction in your course, even though you did not use or you are unaware of the terminology associated with metacognition earlier.

You should get familiar with the terminology through this particular unit. You can look back whether there were few instances of metacognitive instruction in your course, and if so, please write those few instances as bullet points or a short paragraph. We will thank you for sharing the results of these exercises at this address.

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