NBA Accreditation and Teaching – Learning in Engineering (NATE)
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Lecture- 44
Problem Based Approach to Instruction

Greetings, welcome to module 3 unit 4 on Problem Based Approach to Instruction. In the earlier unit we saw Project Based Approach to Instruction. The outcome for this unit is Problem Based Approach to Instruction.

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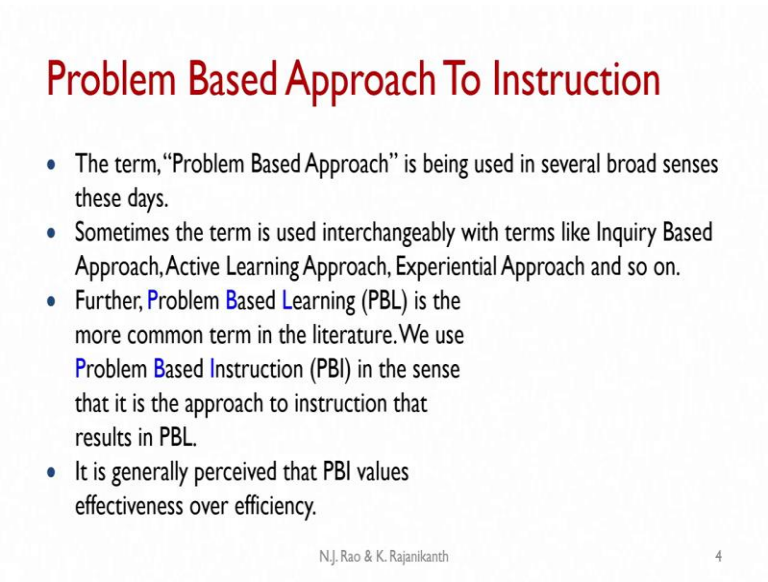

The term Project Based Approach is being used in several broad senses these days. In the previous unit we saw that the same problem existed with project based approach to instruction also. The term Project Based Approach is being used in several different senses. Similarly, the term problem based approach is also being used in several broad senses these days.

Sometimes the term is used interchangeably with terms like Inquiry Based Approach, Activity Based Approach, Experiential Approach and so on. Further, Problem Based Learning is the more common term that you will find in the literature. We use problem based instruction in the sense that it is the approach to instruction that results in problem based learning. It is generally perceived that PBL values effectiveness over efficiency. Thus the focus of PBI is effectiveness.

We will see in later that in general terms PBI may not be very efficient. However, it is quite effective and it is capable of addressing some POs, which are otherwise not addressed by regular

courses. So, we look at what are the key features of problem based approach to instruction. What are its advantages? What are its limitations? And what can be implementation guidelines if the department decides to introduce problem based approach to instruction.

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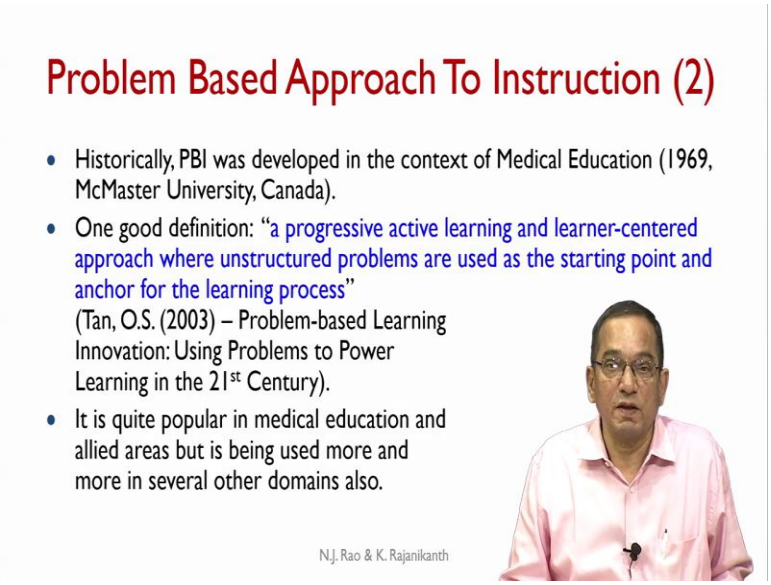

Historically, PBI was developed in the context of Medical Education. It was introduced way back in 1969 at McMaster University, Canada. One good definition for problem based approach to instruction is as follows: A progressive active learning and learner-centered approach where unstructured problems are used as the starting point and anchor for the learning process.

This definition is taken from the work of Tan entitled Problem Based Learning Innovation: Using Problems to Power Learning in the twenty first Century. It is quite popular in medical education and allied areas like nursing. But it is being used more and more in several other domains also. For example, it is being used quite extensively in management education also. Some of the engineering institutes also started to implement problem based approach to instruction.

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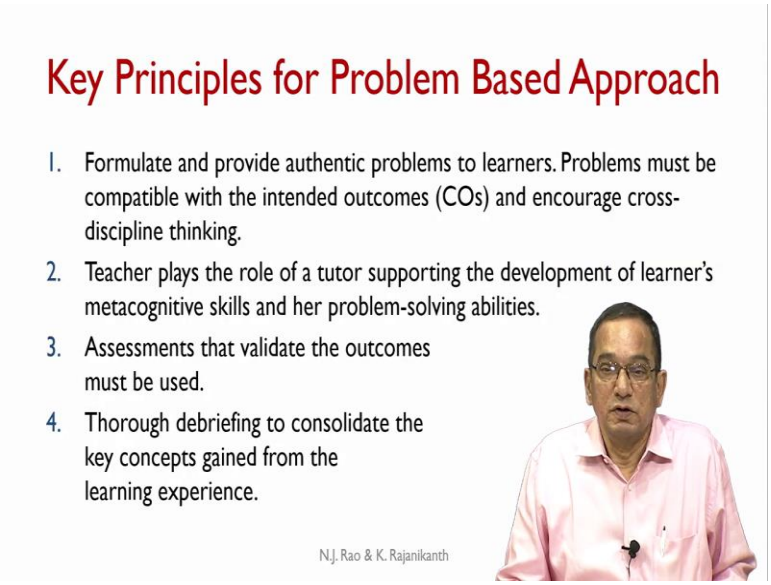

What are the key principles for problem based approach? The first principle is formulate and provide authentic problems to learners. Problems must be compatible with the intended outcomes, course outcomes and encourage cross-discipline thinking. The second principle is that, teacher plays the role of a tutor supporting the development of learner's metacognitive skills and her problem solving abilities.

The third principle is that, assessments that validate the outcomes must be used. And the fourth principle is that, thorough debriefing to consolidate the key concepts gained from the learning experience. There are several other principles which characterized problem based approach. However, these four are the key principles which capture this spirit of problem based approach.

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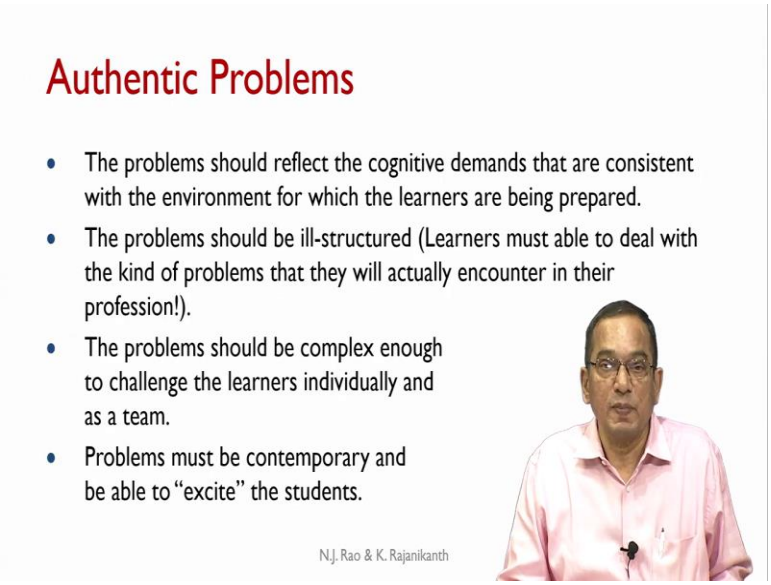

Authentic problems: The problems should reflect the cognitive demands that are consistent with the environment for which the learners are being prepared. The problems that the students faced during the problem based approach to instruction; must be quite similar to the kind of problems that they faced when they become professionals. That is why these problems are called as authentic problems.

They reflect the cognitive demands that are consistent with their professional demands. The problems should be ill-structured. Being ill-structured is a characteristic of the problems that one faces in the profession. Learners must able to deal with these kinds of problems; because these are the kinds of problems that they will actually encounter in their profession. So, the problems should be ill-structured. The problems should be complex enough to challenge the learners individually and as a team. Problems must be contemporary and be able to excite the students.

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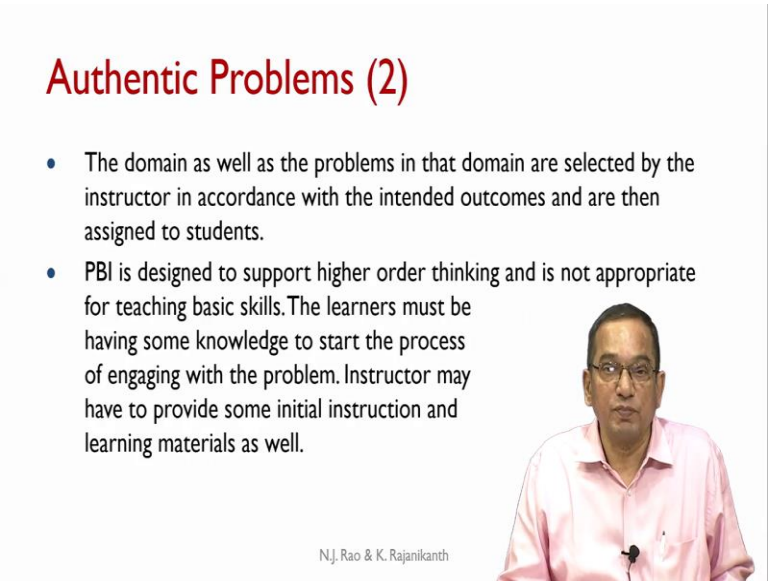

The domains as well as the problems in that domain are selected by the instructor in accordance with the intended outcomes and are then assigned to students. However, instructor can state the problem in a fuzzy fashion to allow the learners practice problem formulation skills also. Instructor does select the domain, thus select the problem and assigned it to the student.

However, the problem need not be stated in a totally precise fashion. PBI is designed to support higher order thinking and is not appropriate for teaching basic skills. It is assumed that the learner has some basic knowledge which enables her to start the process. This basic knowledge should be sufficient for the learner to engage with the problem.

If the learner does not have this basic knowledge; instructor may have to provide initial instruction to help the student to capable of engaging with the problem. Instructor may also have to provide some learning material as well. Once the student reaches certain level of maturity she will be able to engage a realistic problem as required in this approach.

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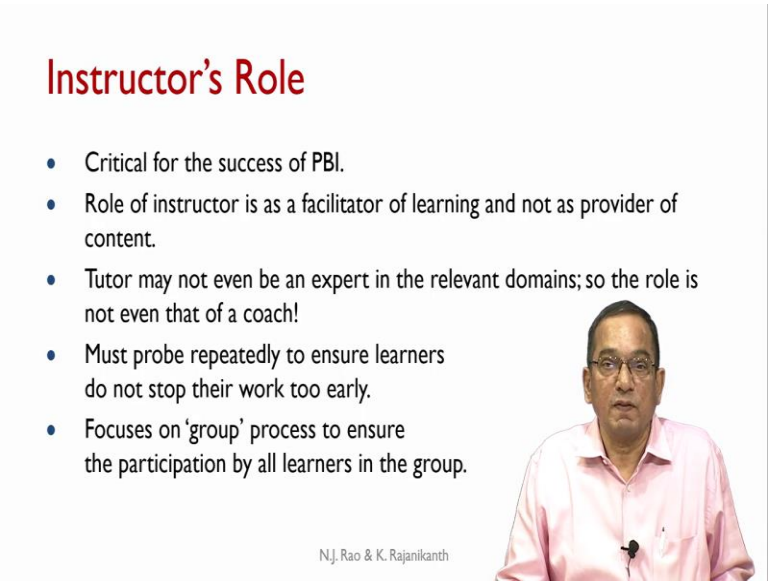

The instructor's role is very crucial for the success of PBI. The role of the instructor is as a facilitator of learning; it is not that of a provider of the content. The instructor acts more like a mentor or facilitator or a tutor. It is to be noted that the tutor may not even be an expert in the relevant domain. The tutor may not be all that familiar with the domain in which the students are working. His role is not to act as an expert; his role is only as a facilitator.

So, the role is not even that of a coach, it is that of a facilitator. But instructor must probe repeatedly to ensure that the learners do not stop their work too early. The learning process does not terminate prematurely. Instructor must focus on the group process to ensure that participation by all learners happens. For PBI to succeed, it is essential that every participant in the group engages with the problem. Instructor must focus on this group process also.

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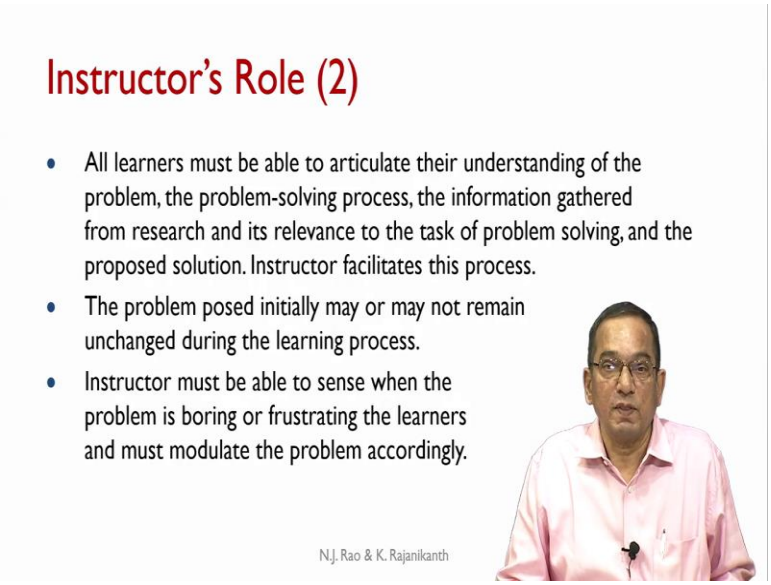

All learners must be able to articulate their understanding of the problem, the problem-solving process, the information gathered from research and its relevance to the task of problem solving and the proposed solution. Instructor facilitates this process. The problem posed initially may or may not remain unchanged during the learning process; both possibilities exist. Instructor must closely monitor the progress of the group.

He must be able to sense when the problem is boring or frustrating the learners. If it is the case that the problem is frustrating the learners, then instructor must modulate the problem accordingly. If the group is progressing well, instructor may leave the problem unchanged if necessary instructor modulates the problem. For this it is essential that instructor monitors the progress of the group vey closely.

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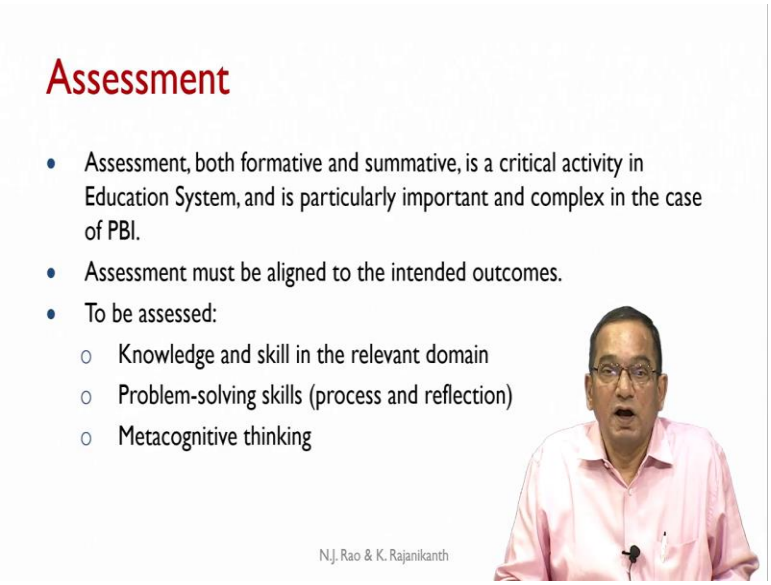

Assessment both formative and summative is a critical activity in education system. We have seen these aspects several times. This is particularly important and complex in the case of PBI. Assessment must be aligned to the intended outcomes; that is course outcomes. Knowledge and skill in the relevant domain must be assessed. Problem-solving skills also must be assessed. Metacognitive thinking also needs to be assessed.

One of the key features of the PBI is that it promotes metacognitive thinking in the learners. So, instructors must assess the metacognitive thinking abilities of the learners. So, knowledge and skills in the relevant domain must be assessed, problem-solving skills must be assessed and metacognitive thinking also must be assessed.

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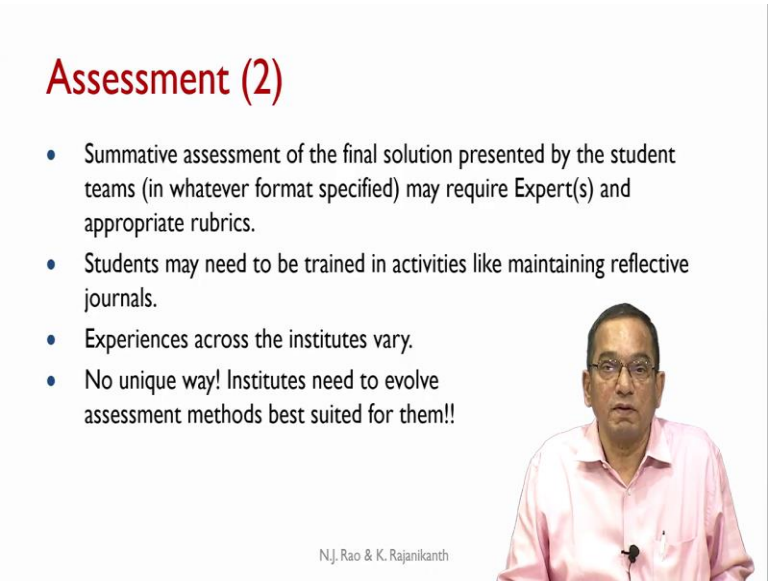

Summative assessment of the final solution presented by the student teams must be assessed. But it may be the case that the tutor is not a domain expert. Thus the assessment of the final solution presented by the student teams may require the assistance of the external experts; that is okay. Whatever the format specified by the department, the students have to submit the final solution in that particular format.

And if the assessment requires the evaluation by the external experts; the department makes must arrangements to invite such external experts. It is evident that we also need proper rubrics to evaluate the students. The rubrics must be defined and shared with the students upfront. Some activities like maintaining reflective journals are very important for the benefits of PBI to the substantial. However, not all learners may be familiar with the concept of a reflective journal.

So, students may need to be trained in activities like maintaining the reflective journals. Reflective journals allow students to record their thought processes while they are engaged in solving the authentic problem. Such a journal would help the students during the final phase of debriefing also. Teachers may have to train students in the art of maintaining reflective journals. Experience across the institutes varies; there is no unique way of performing the assessment. Institutes need to evolve assessment methods best suited for them.

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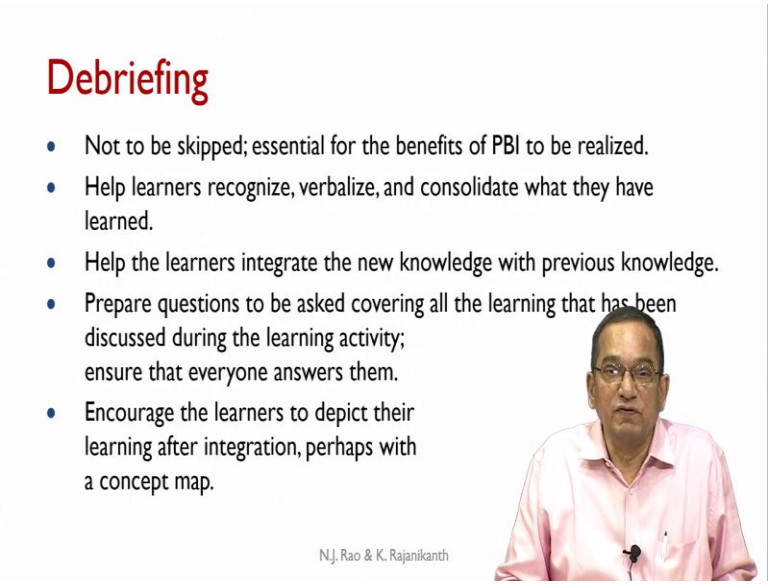

Debriefing is considered as the most important phase of PBI. This should not be skipped; it is essential for the benefits of the PBI to be realized. Debriefing helps learners recognize, verbalize and consolidate what they have learned. It helps the learners integrate the new knowledge with previous knowledge. In an earlier unit while we were discussing the first principles of learning stated by Merrill.

We observed that reflection is a key aspect of deep learning. Debriefing in some sense is such a reflection activity. It helps the learners integrate the new knowledge with the previous knowledge. During the debriefing instructors must ask questions covering all aspects of learning that happened during the implementation of the PBI. For this it is better if the instructor prepare the questions in advance.

Instructor prepares questions to be asked covering all the learning that has been discussed during the learning activity. We already noted that instructor closely monitors the progress of the teams. So, instructor is familiar with the discussions that happened during the problem solving phase. The discussions among the group members; the questions that were raised by the group members and the answers provided by the group members.

Instructor can prepare a set of questions covering all these aspects. Instructor must ensure that everyone answers them; this very important. We cannot have a single student acting as the

spokesperson of the group and answering all the questions. It is essential that every student faces the questions and answers them.

Encourage the learners to depict their learning after the integration, perhaps with a concept map. This allows the students further in integrating their newly acquired knowledge with the previous knowledge. Learners can be asked to prepare a concept map showing the integration of the new knowledge with the previous knowledge.

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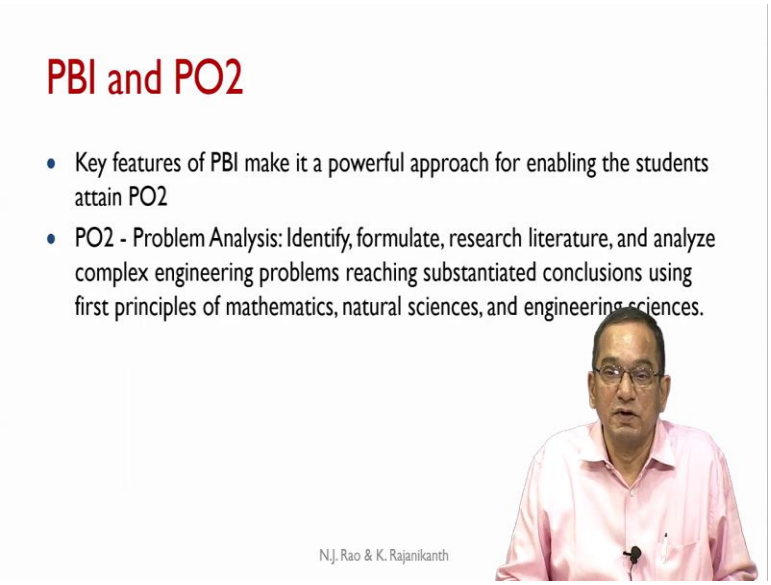

If we look at the key features of PBI, we can immediately see that it is closely related to the PO2. Key features of PBI make it a powerful approach for enabling the students to attend PO2. Recall that PO2 deals with problem analysis. Students are supposed to be able to demonstrate their ability to identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences that is PO2.

We have seen that in PBI students try to formulate the problem as an engineering problem. They also research literature, they analyze the problem to reach substantiated conclusions, they defend their solutions. Thus the activities undertaken by the students during the process of the implementation of PBI closely match the activities that support the attainment of PO2. Though there are implementation difficulties with respect to PBI, it is worthwhile for institutes to try to implement PBI; because of this close correspondence between PBI and PO2.

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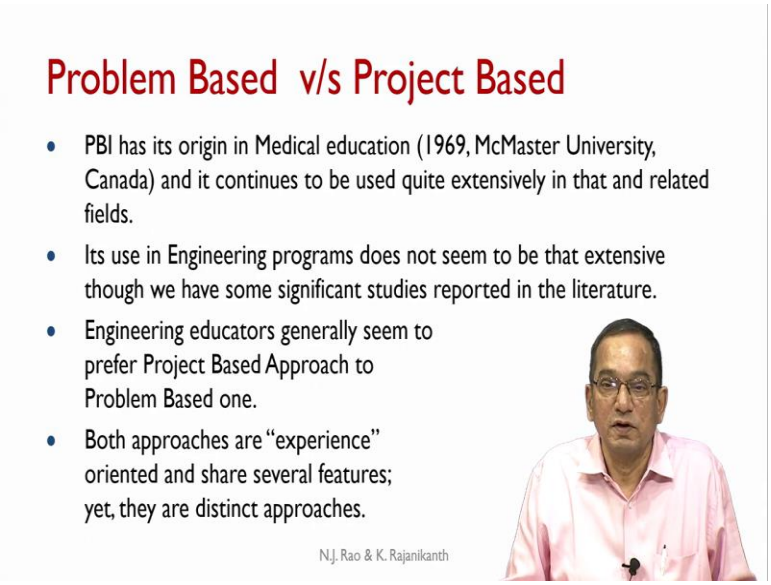

We have looked at project based approach to instruction in the previous unit. We also noted that both project based approach to instruction and problem based approach to instruction try to address many POs which cannot be addressed adequately by regular common engineering courses. How do they compare with each other?

There can be several criteria based on which we can compare problem based approach with project based approach. We look at some of the criteria here. PBI has its origin in medical education as we mentioned earlier and it continuous to be used quite extensively in that. And that related fields like nursing and other healthcare professions. Its use in the engineering programs does not seem to be that extensive.

We do have some case studies reported in the literature regarding the implementation of the PBI approach in the engineering institutes. However, these reports are quite small in number. Engineering educators generally seem to prefer project based approach to problem based one. Both approaches are experience oriented and share several features; yet, they are distinct approaches.

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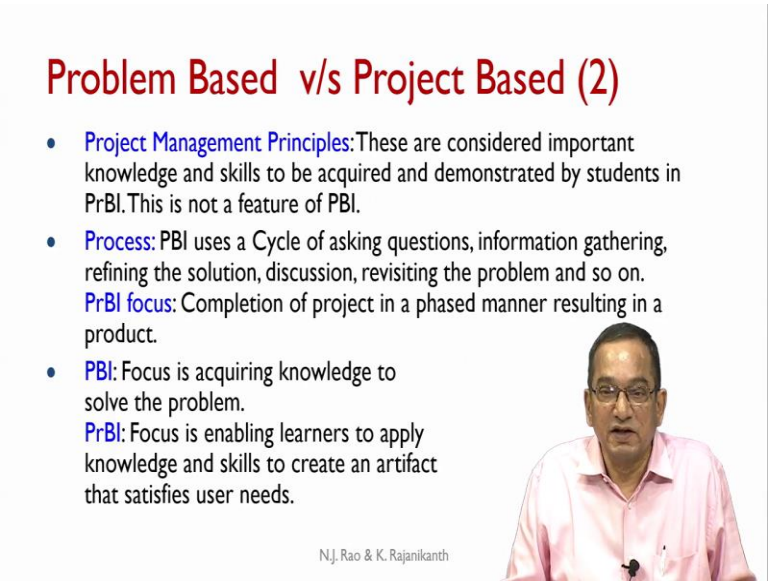

Let us look at how these two approaches fair with respect to the criteria of the project management principles. Project management principles are considered important knowledge and skills to be acquired and demonstrated by students in engineering education. Project based approach to instruction emphases this fact and considers that students must demonstrate project management principles.

However, this is not a key feature of PBI. There is no concept of a project in problem based approach to instruction. Project based approach as the very name implies focuses on the work of the students as a project work. If you look at the process that is followed by these two approaches; we see that PBI uses a cycle of asking questions, information gathering, refining the solution, discussion and revisiting the problem and so on.

The students go through this cycle several times. They ask questions, they gather the information, they refine the solution, they discuss the solution and revisit the problem if required. This cycle is repeated as many times as required. The focus in project based approach on the other hand is completion of the project in a phased manner resulting in a product.

So, there is difference in the process that is adopted by the PBI and the process adopted by project based approach to instruction. PBI focuses on students acquiring knowledge to solve the problem. The focus of PBI is problem solving ability. The focus of project based approach to

instruction is that learners are able to apply knowledge and skills to create an artifact. This artifact must satisfy the user needs as stated upfront.

So, the focus of project based approach to instruction is that of creation of an artifact to satisfy the requirement stated upfront. There is a difference between these two approaches. In PBI any solution produced by the students is acceptable, if the students are able to defend that solution; and if the process followed by the students is an adequate one. However, in project based approach the final product developed by the students must satisfy the requirements stated upfront.

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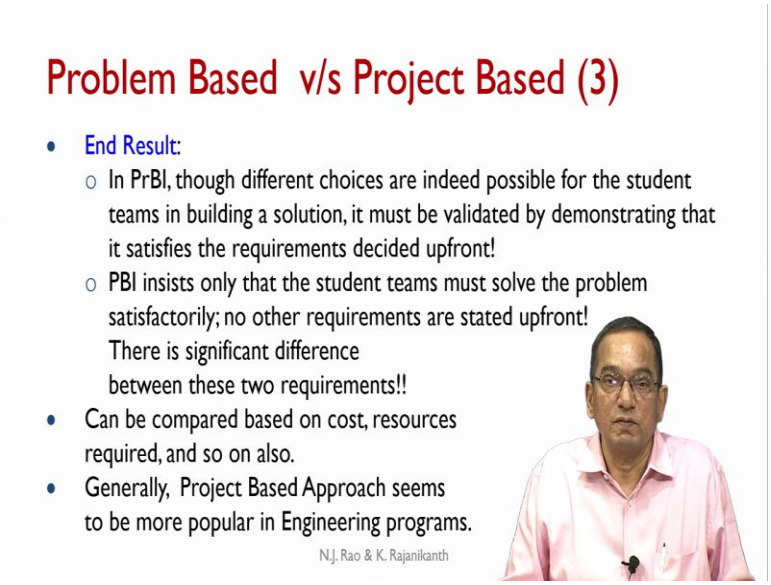

In other words, the end result expected from the students is different in these two approaches. In project based approach though different choices are indeed possible for the student teams in building a solution. It must be validated by demonstrating that it satisfies the requirements decided upfront. The requirements are given at the initial stage of the work. The final product must be shown to satisfy those requirements.

Students must validate the solution produced by them. PBI insists only that the student teams must solve the problem satisfactorily; no other requirements are stated upfront. There is significant difference between these two requirements. The focus of PBI is on problem solving abilities only. They can be compared on several other criteria also.

For example, we can compare these two approaches based on cost, resources required and so on. But the criteria that we have compared so far are the most key feature. Generally, project based approach seems to be more popular in engineering programs. However, given that problem based approach is capable of addressing PO2 quite effectively. It may be worthwhile for departments to explore the implementation of PBI in their curricula.

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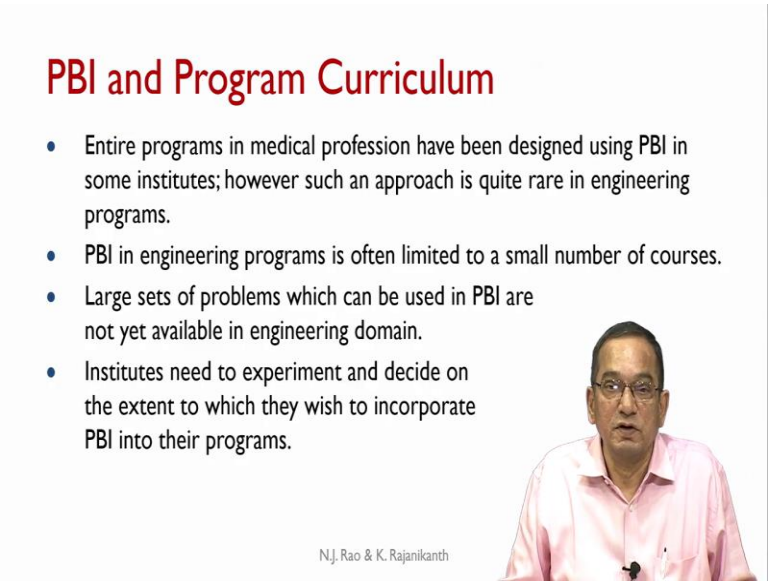

Entire programs in medical profession have been designed using PBI in some institutes; however such an approach is quite rare in engineering programs. PBI in engineering programs is often limited to a small number of courses.

The implementation of PBI in engineering institute typically involves replacing the laboratory component of an integrated course with a realistic set of problems. Large sets of problems which can be used in PBI are not yet available in engineering domain. Institutes need to experiment and decide on the extent to which they wish to incorporate PBI into their programs.

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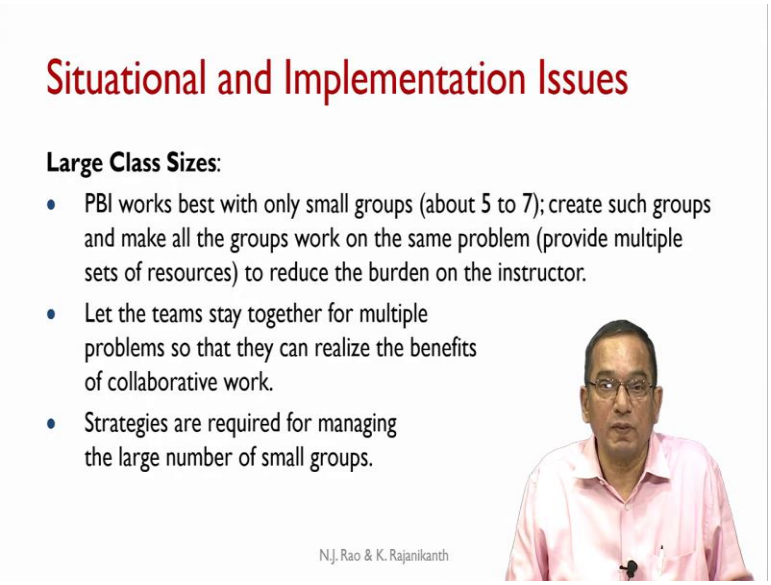

There are some situational implementation issues with respect to PBI. Typically engineering classes are large in size. PBI works best with only small groups of about 5 to 7 students. A typical engineering class may have 60 to 70 students. So, if the department wishes to implement the problem based approach to instruction, it must create small groups. That may mean creating many resources.

One possible way of solving this issue is to create small groups, but make all the groups to work on the same problem. And in such a case the department has to provide multiple sets of resources; but this will certainly reduce the burden on the instructor. Another important guideline can be to let the teams stay together for multiple problems.

This will help them to in realize the benefits of collaborative work. Teams are not to be changed frequently; the same teams must continue to work on different problems. This will help them appreciate the benefits of collaborative work. Of course we need strategies to manage the large number of small groups.

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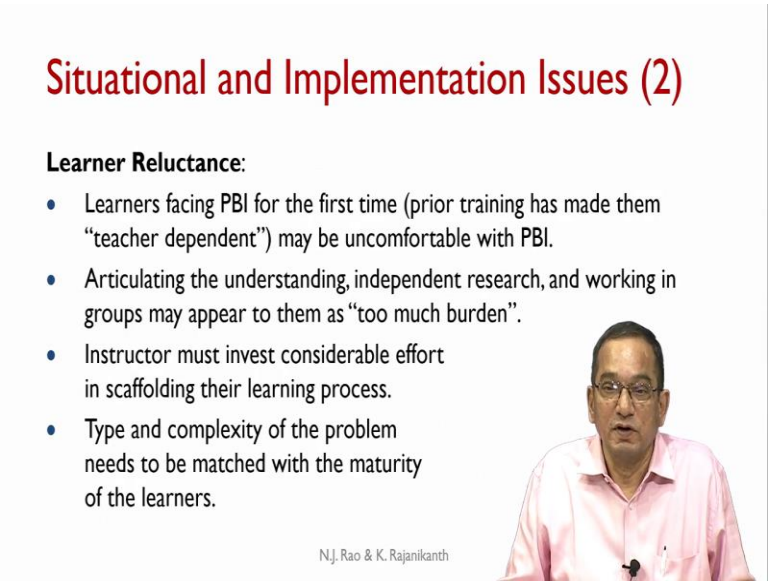

There is another issue of leaner reluctance when PBI is implemented in a department. Learners facing PBI for the first time may be very uncomfortable with the approach used in PBI. Prior training has made the learners dependent on the inputs provided by the teacher. They are accustomed to the role of passive receivers of information. PBI requires the students to engage with the problems in a more active fashion.

Articulating the understand, independent research and working in groups may appear to the students as too much burden. Instructor must invest considerable effort in scaffolding their learning process. The types and the complexities of the problems needs to be matched with the maturity of the learners.

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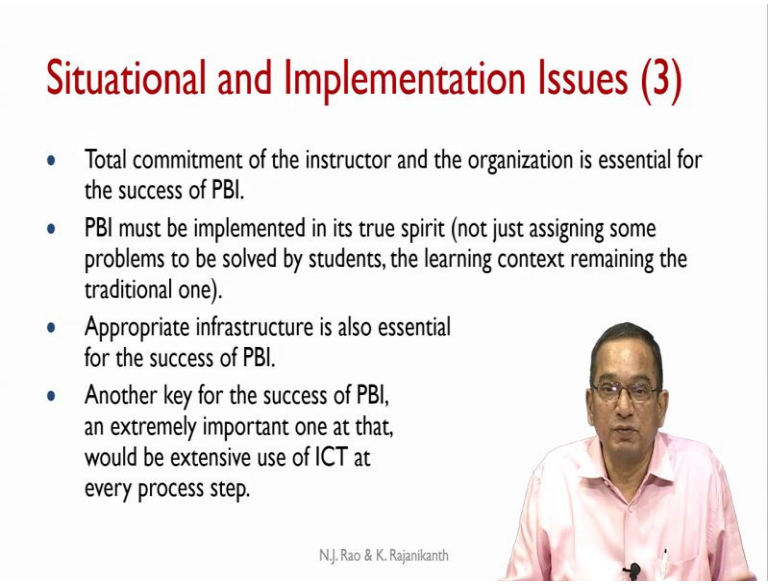

Total commitment of the instructor and the organization is essential for the success of PBI. PBI must be implemented in its true spirit if the benefits have to accrue. Assigning some problems to be solved by the students with the learning context remaining the same is not problem based approach. If the department wishes to implement the problem based approach to instruction; it must to do so in all its true spirit.

Appropriate infrastructure is also essential for the success of the PBI. Students need to sit together and discuss. They need physical space where they can carryout this process of discussions more comfortably. Another key for the success of PBI, an extremely important one at that, would be extensive use of ICT at every process step. This would reduce the burden of the faculty as well as the burden of the learners.

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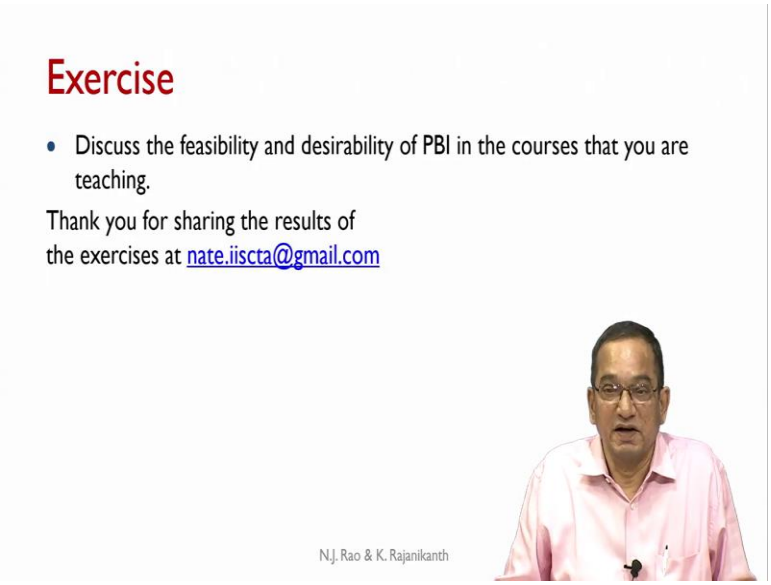

An exercise for you – Discuss the feasibility and desirability of PBI in the courses that you are teaching. Thank you for sharing the results of the exercises at nate.iiscta@gmail.com.

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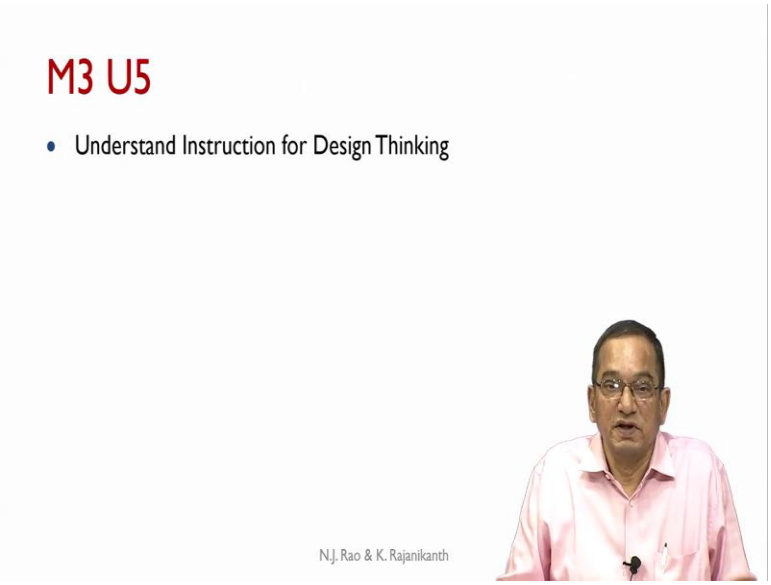

In the next unit will understand the instruction for design thinking. Thank you.