NBA Accreditation and Teaching – Learning in Engineering (NATE)
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Indian Institute of Science, Bengaluru
Lecture- 43
Project-Based Approach To instruction

Welcome to module 3 unit 3 on Project-Based Approach to Instruction.

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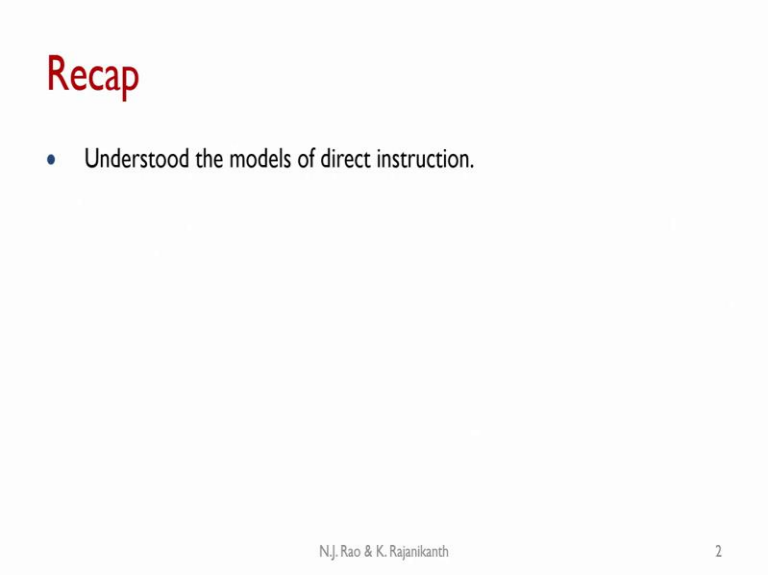

In the earlier unit we understood the models of direct instruction specifically, transaction model of direct instruction.

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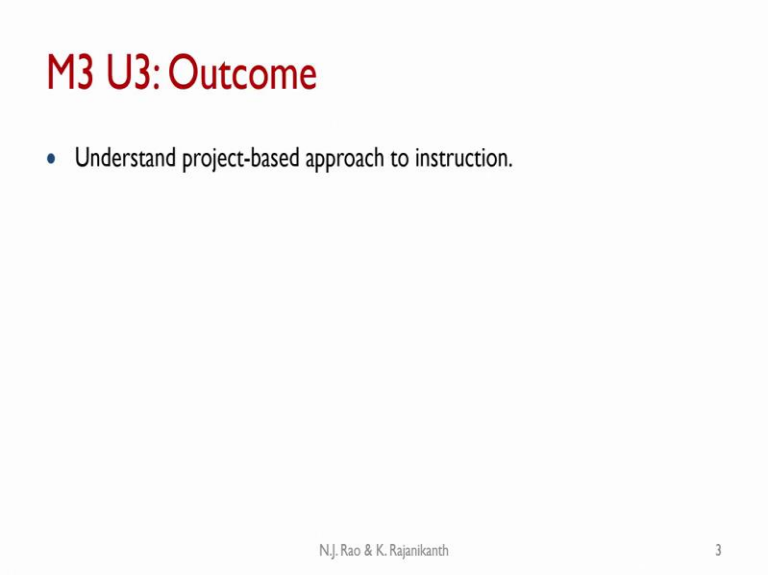

In this unit will understand project-based approach to instruction.

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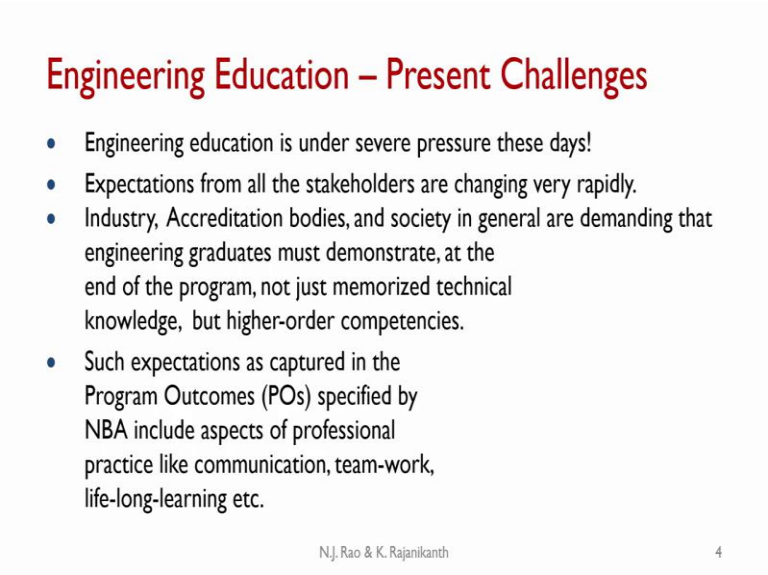

In a general sense Engineering Education is going through some sort of a crisis these days; it is under severe pressure. Expectations from all stakeholders are changing very rapidly. Industry, Accreditation bodies, and society in general are demanding that engineering graduates must demonstrate, at the end of the program, not just memorized technical knowledge, but higher-order competencies.

The expectations are becoming more and more stringent. Such expectations as captured in the Program Outcomes (POs) specified by the NBA include aspects of professional practice like communication, team-work, life-long-learning et-cetera.

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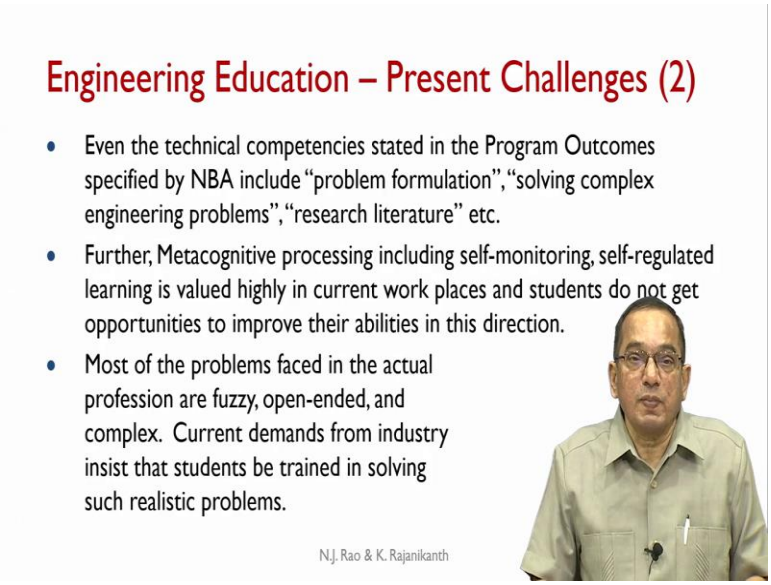

Even the technical competencies stated in the POs of NBA include aspects like "problem formulation", "solving complex engineering problems", "research literature" et-cetera. Most of the formal engineering curricula available presently in India really do not address issues like problem formulation or complex engineering problems.

Further, Metacognitive processing including self-monitoring, self-regulated learning is valued highly in the current work places and students do not get opportunities to improve their abilities in this direction. There is not much instruction that happens in normal engineering programs; that promotes the Metacognitive processing abilities of students. Most of the problems faced in the actual profession are fuzzy, open-ended, and complex.

Current demand from industry insist that students be trained in solving such realistic problems. In contrast, the problems with which the students work in the engineering programs are highly structured. The problem is specified very clearly and students practice on such structured fully specified problems. They are not exposed to open-ended problems, fuzzily stated problems,

incomplete problems. They demand from the industry is that students must be trained in solving that problems which have more realistic flavor.

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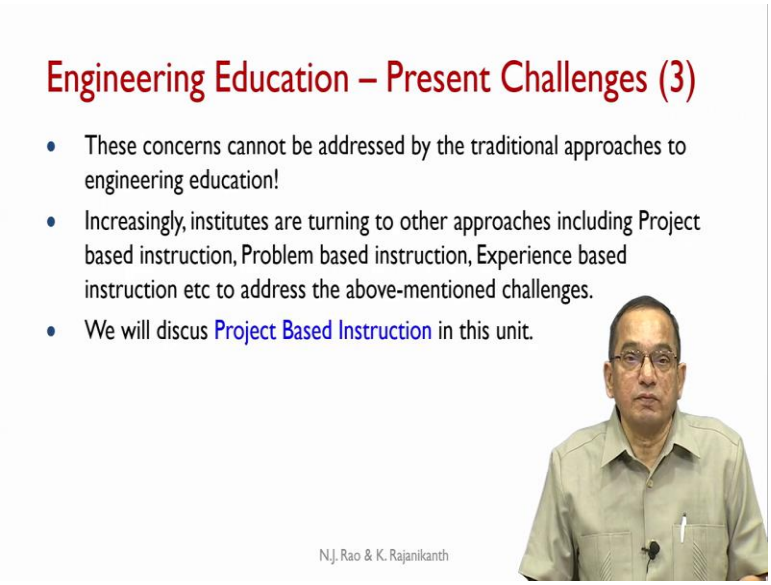

These concerns cannot be addressed by the traditional approaches to engineering education. Increasingly, institutes are turning to other approaches including Project-based instruction, Problem based instruction, Experience based instruction and so on to address the above-mentioned challenges.

Institutes cannot remain mute to the challenges. They need to address these challenges; hence they are exploring the alternate approaches to instruction. In this unit we will discuss project based instruction and in a later unit we look at problem based approach to instruction.

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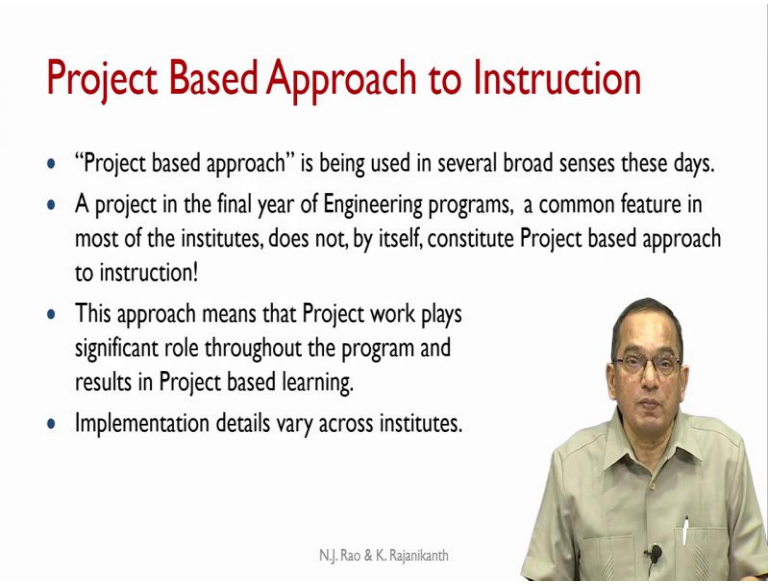

Project based approach is being used in several broad senses these days. The term has become quite popular, but its usage does not seem to follow any one single consistent pattern. A project in the final year of Engineering program, a common feature in most of the institutes, does not by itself, constitute project-based approach to instruction. In other words, one single final year project does not mean that, the institute is practicing project based approach to instruction.

This project in the final year is typically called as the Capstone project in the US. But, in India we are more accustomed to calling it as simply final year project. That is quite common in the engineering curriculum; but this does not comes to project based approach to instruction. The approach means that project work plays significant role throughout the program and results in project based learning.

The curriculum must provide several opportunities for the students to learn through the projects. Some regular courses also can be offered in project mode. There must be several opportunities for students to learn based on project work. Then we can say that the institute is practicing project based approach to instruction. Implementation details vary across institutes. But many institutes are trying to implement project based approach to instruction based.

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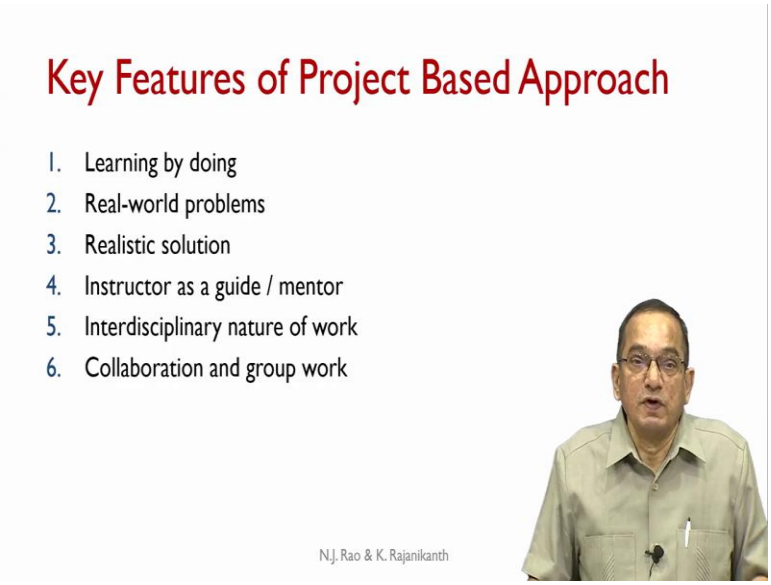

Key features of project based approach; there are six key features. Learning by doing, Real-world problems, Realistic solution, Instructor as a guide and are mentor, Interdisciplinary nature of work, Collaboration and group work. There are other features of project based approach, but we can consider these six features as the key elements of a project based approach.

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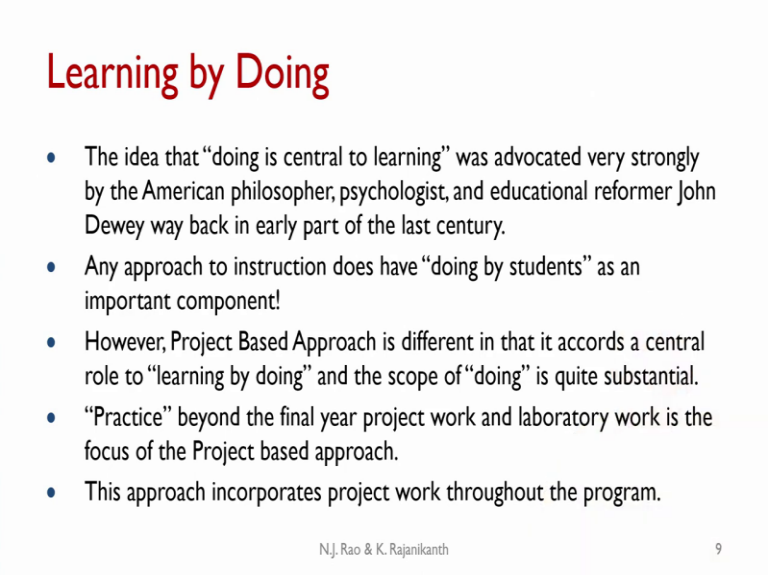

The idea that "doing is central to learning" was advocated very strongly by the American philosopher, psychologist and educational reformer John Dewey way back in early part of the last century. It is quite an old idea. An approach to instruction must have this doing by the

students. This was known for quite long time. Any approach to instruction does have doing by instruction as an important component.

However, Project based approach is different in that it accords a central role to quotes "learning by doing" unquote and this scope of doing is quite substantial. Practice beyond the final year project work and laboratory work is the focus of project based approach. Thus this approach incorporates project work throughout the program. The curriculum has many components which require the student to work and learn through work.

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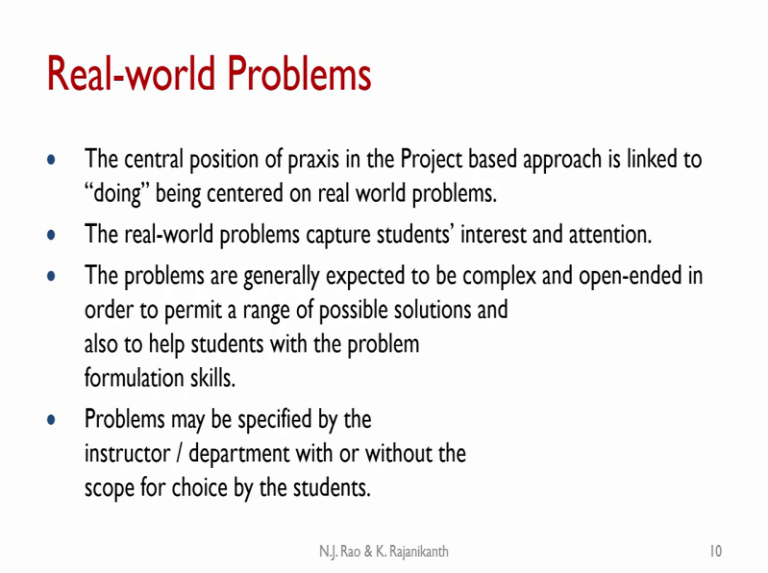

The central position of praxis in the Project based approach is linked to doing being centered on real world problems. The focus is on real world problems. The real-world problems capture students' interest and attention. The problems are generally expected to be complex and open-ended in order to permit a range of possible solutions and also to help students with the problem formulation skills. When the problem is stated, in a natural language and in a fuzzy way; students need to acquire the skills of formulating it as a proper engineering problem first.

Thus, the problem formulation skills are learnt by students in this activity. Problems may be specified by the instructor or the department with or without the scope for choice by the students. Generally the preferred scenario is that students do get some choice in the project work selection. However, the practical constituents may force sometimes the instructors to assign the ideas to be worked on to the student teams.

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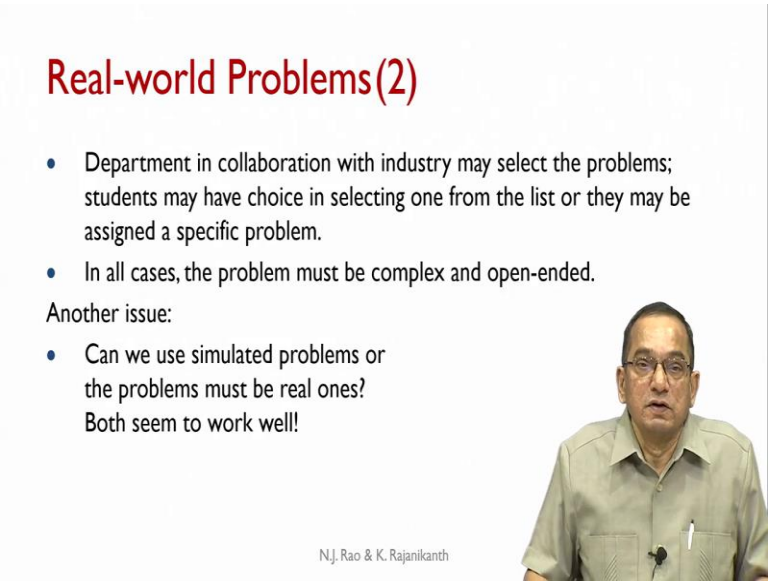

Department in collaboration with industry may select the programs. This can happen if there is a good functional MOU within industry. The department may collaborate with the industry in a long term fashion and it may be ready to pick up some problems which are of interest to that particular industry. And these problems may be offered as project areas to the students.

Students may have a choice in selecting one problem from the given list or there may be assigned a specific problem. In all these cases problems must be complex and open-ended. They cannot be the typical, well structured and neatly formulated problems. They need to have this open-ended nature in order to promote good learning by the students. There is another issue with these real-world problems.

Can we use simulated problems or should the problems be real ones? In some context, students may be able to work on real problems. However, the department may have certain difficulty in providing the real-world problems to the students. In such cases the department may provide simulated problems. Is this approach okay? Now it seems that in practice both seem to be working well. As long as problems are complex and open-ended, whether they are simulated or real? Student seems to be learning substantially from working on such problems.

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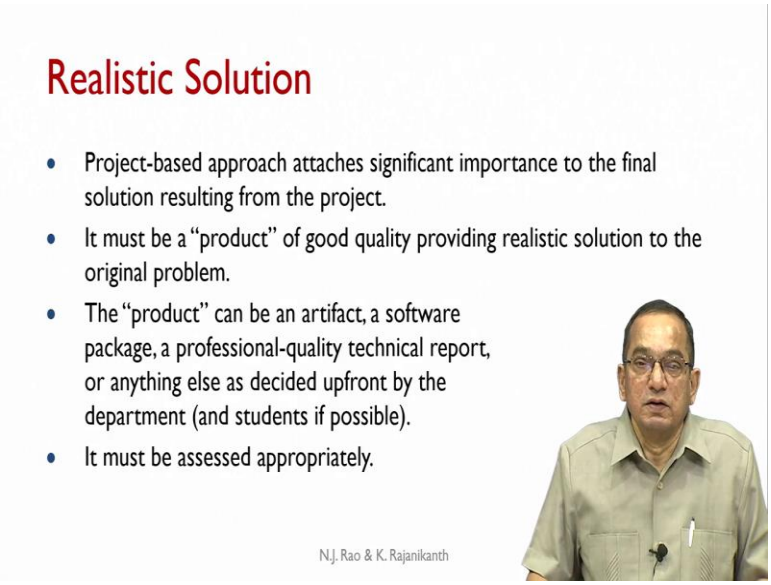

Another key feature of this approach is that the solution is expected to be a realistic solution. Project-based approach attaches significant importance to the final solution resulting from the project. It must be a product of good quality providing realistic solution to the original problem. The product can be artifact, a software package, a professional-quality technical report or anything else as decided upfront by the department.

Students also may have a say in the kind of final product that they wish to produce. In any case it is important to produce a final product that is of professional quality and it must be assist appropriately by the department.

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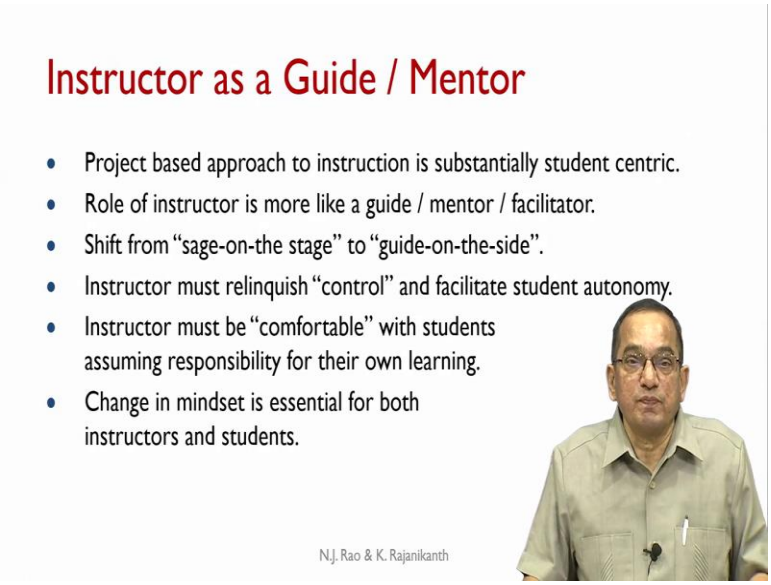

Another key feature of project based approach concerns the instructor. In the traditional format the instructor is more like a sage-on-the-stage. Instructor provides the instruction as an expert. But in the project based approach to instruction a substantially student centric activity, the role of the instructor changes. It is more like a guide or a mentor or a facilitator. There is a shift in the role of the teacher from sage-on-the-stage to guide-on-the-side. Instructor must relinquish control and facilitate student autonomy.

Students must be able to work more or less independently, make there own design decisions and justify them. Instructor must be comfortable with students assuming responsibility for their own learning. This requires a change in the mindset of both the teacher and the students. But, such a change in the mindset is essential for the success of project based approach to instruction. A change in the mindset of both the teacher and the student is essential.

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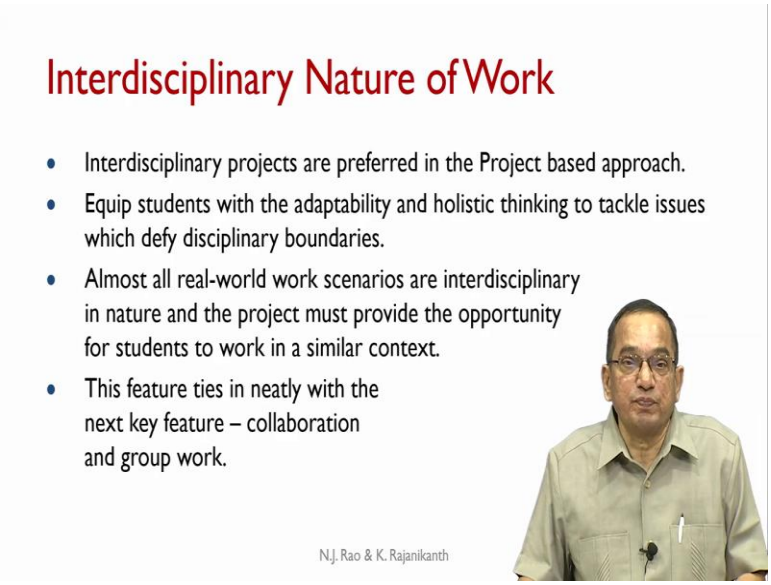

Another key feature is Interdisciplinary nature of the work. In real-world practically all the activities are interdisciplinary in nature. It is only in the academic world that most of the students work in independent silos. Interdisciplinary projects are preferred in the project based approach because of this reason.

They must equip the students with the adaptability and holistic thinking that is necessary to tackle issues which defy strict disciplinary boundaries. Almost all the real-world scenarios are interdisciplinary in nature and the project must provide the opportunity for students to work in a similar context. This is again a feature which is generally absent even in the final year projects as they are implemented in the current scenario.

Most of the projects are confined to the domain of knowledge that is very specific to the department concern. Very rarely students get an opportunity to work on interdisciplinary projects. But, for the project-based approach to instruction to succeed mature to the projects must be interdisciplinary in nature. This feature ties in neatly with the next key feature which is, Collaboration and group work.

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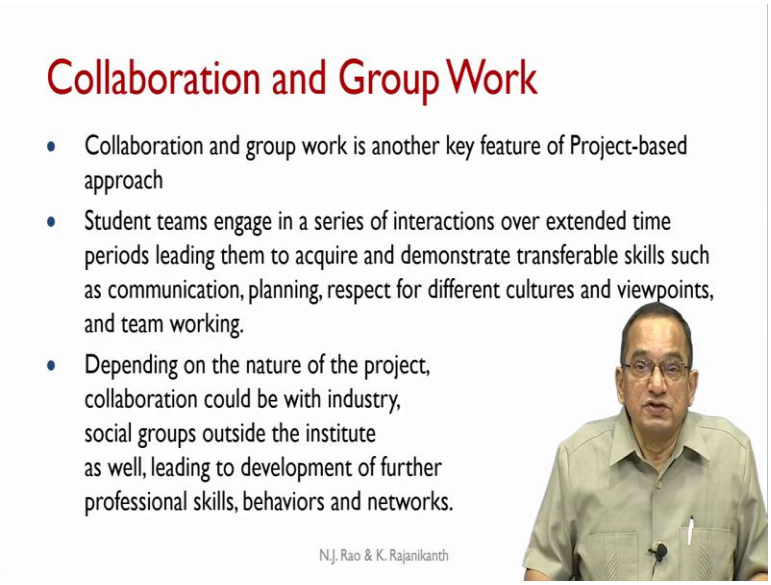

Collaboration and group work is very essential for the students to acquire the kind of skills required to succeed in real industrial scenario. Student teams engaged in a series of interaction over extended time during the project work. And this leads them to acquire and demonstrate transferable skills such as communication, planning, respect for different cultures and viewpoints and team working.

Depending on the nature of the project, collaboration could be with industry, social groups outside the institute as well, leading to development of further professional skills, behaviors and networks. Sometimes the students able to work in a nearby community on problems that are relevant to that community. Thus students get exposure to interactions with the real-world; this would further enhance their professional skills.

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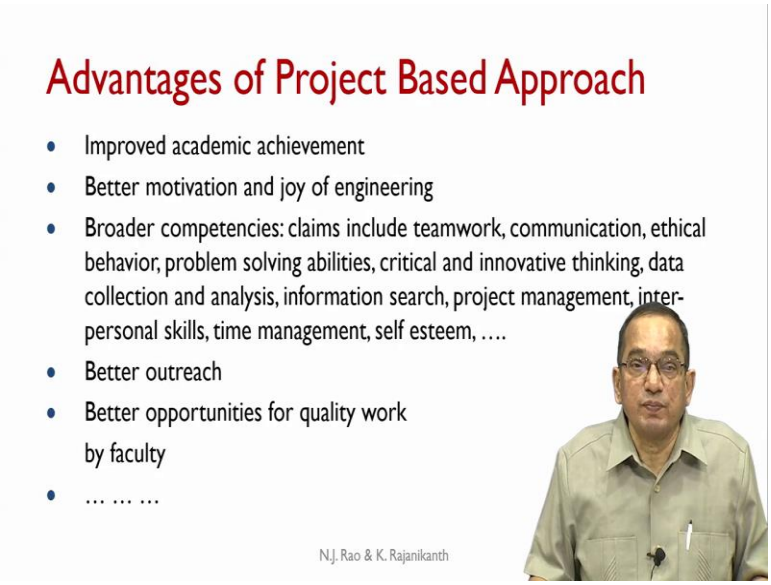

There are several advantages of project based approach. It leads to improved academic achievement. It leads to better motivation and joy of engineering. And students acquire and are able to demonstrate a broad range of competencies. It is not merely an academic knowledge that the students gain. They are able to get a several professional skills which are very important for success in today's competitive industrial scenarios.

The claims made of the project based approach include teamwork, communication, ethical behavior, problem solving abilities, critical and innovative thinking, data collection and analysis, project management, inter-personal skills, time management, self esteem; the list seems to be endless. But, many of these benefits do occur when project based approach to instruction is implemented in its true spirit in its institute.

And many of these competencies are directly related to the POs specified by NBA. Better outreach is also possible, better opportunities for quality work by faculty also exist. Particularly, if there is a collaboration between the department and the industry and if the students work on the projects related specifically to the problems of that industry, the faculty guiding such projects do get an opportunity for better quality work. Thus, this approach is beneficial for the faculty also.

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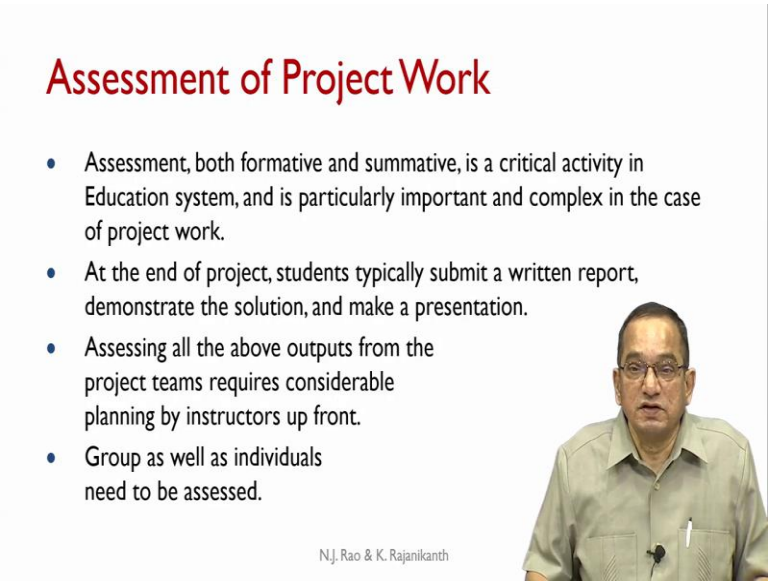

There are some issues related to the assessment of the project work. Assessment, both formative and summative is a critical activity in any education system and this is particularly an important and complex in the case of project work. At the end of the project students typically submit a written report, demonstrate the solution and make a presentation.

Addressing all the above outputs from the project teams requires considerable planning by instructors up front. Groups as well as individuals need to be assessed. The contribution by the group must be evaluated and the student's individual contribution in the group needs to be evaluated separately.

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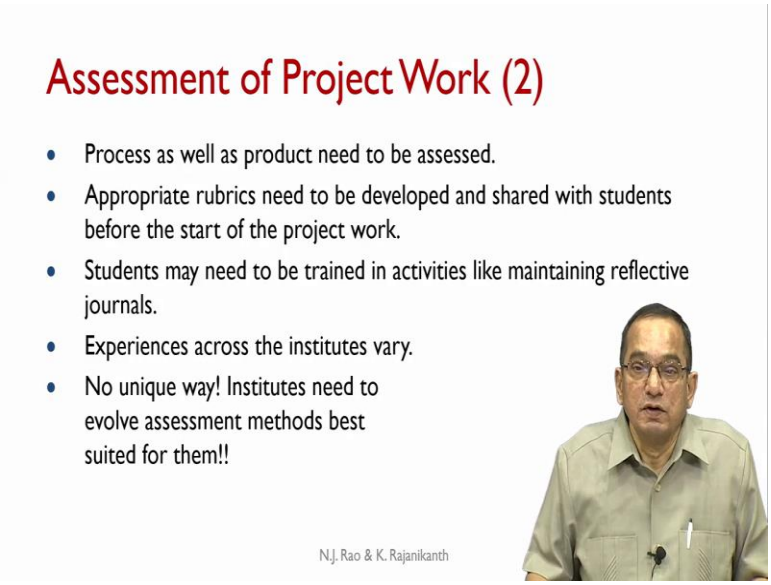

The process as well as the product needs to be assessed. The final solution presented by the project team needs to be assessed. Easily, equally important to assessed the adherence to the process also. Thus process as well as product needs to be assessed. Appropriate rubrics need to be developed and shared with students before the start of the project work.

Any, specific competency that we expect the students to acquire and demonstrate because of the project work, becomes possible only if the rubrics have a reference to such specific skill are acknowledge to the ability. Students may need to be trained in activities like maintaining reflective journals. They are not generally exposed to the intricacies involved in maintaining the reflective journals.

Such journals help the students reflect on the knowledge, skills that they have acquired and integrate this knowledge and skills with their prior mental models. Students may need training in this area. Experiences across the institutes vary in this regard. No unique way of managing the assessment of project work. Institutes need to evolve assessment methods best suited for them.

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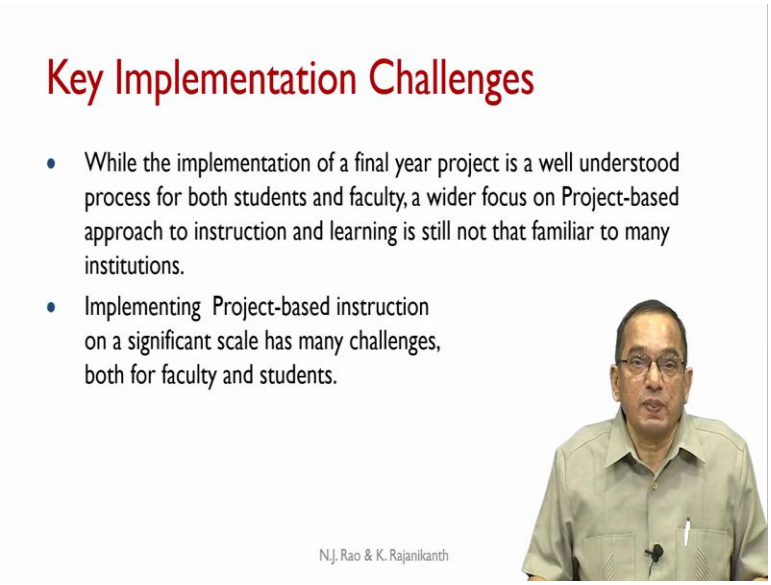

There are several key implementation challenges, challenges for faculty, challenges for students also in adapting in project based approach to instruction. While the implementation of a final year project is a well understood process for both students and faculty. A wider focus on project based approach to instruction and learning is still not that familiar to many of instructors or students.

The final year project has been a regular feature of engineering curricula for a long period and hence the institute, students as well as faculty are quite comfortable and the familiar with the process. But when project based approach to instruction is adopted the emphasis on the project work increases significantly. And this may be a new scenario for the institutes, students as well as faculty. Implementing project based instruction on a significant scale has many challenges both for faculty and students.

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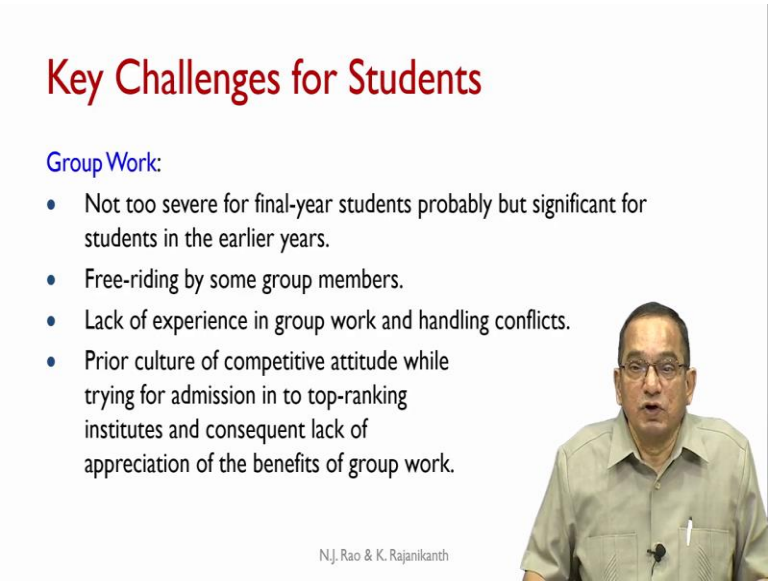

What are the key challenges for students? The first key challenge is the ability to work in a group work; group work is the first challenge. This may not be too severe for final year students, but significant for students in the earlier years. This would be a real challenge particularly students in first year. The prior culture of the first year students is of a competitive nature.

Students in their plus two level studies are accustomed to a competitive attitude; while trying for admission into the limited number of seats available in top ranking institutes. Thus when the students enter the engineering institutes they come with a competitive mindset. The appreciation of benefits of group work are not yet made accessible to students. They are not really familiar with the benefits of group work. It may be very difficult for them to switch from a competitive mode of working to a cooperative mode of working.

In group work there is another problem and that is the problem free-riding by some group members. In any group work it is quite likely that, some students really do not contribute in any reasonable fashion to the total work; essentially they free-ride the work. How to ensure that all the students contribute in a group is one of the key challenges for project based approach. Lack of experience in group work and handling conflicts also occurs quite frequently.

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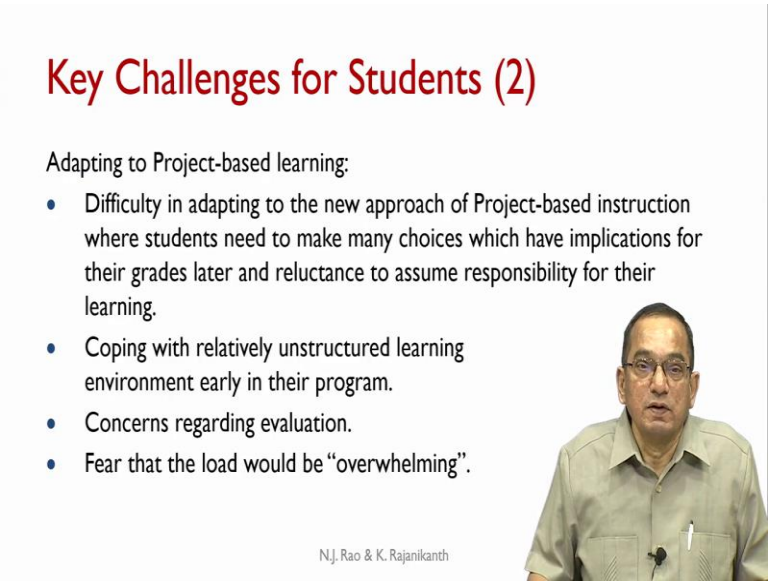

Another difficulty is in adapting to project based learning. Students are generally accustomed to working under the direct guidance of teachers. They are, accustomed to receiving wisdom from the students. So, there is difficulty in adapting to the new approach of project based instruction, where students need to make many choices which have implications for their grades.

And they themselves have to make these choices and they are generally reluctance to assume responsibility for their learning; coping with relatively unstructured learning environment early in their programs, may not be very easy for many of the students. They also may have concerns regarding the evaluation. Many of the students may have fear that the load would be overwhelming. They may have preferred regular courses where they can study and be confident of getting good grades in a manner with which they are familiar.

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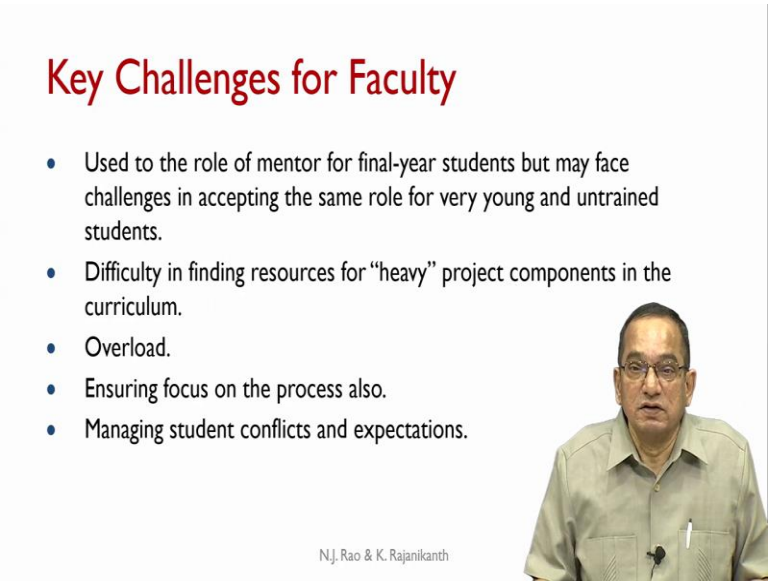

There are challenges for the faculty also. They are used to the role of being a knowledge provider and perhaps they are also used to the role of being a mentor of final year students. But they may have certain difficulties and certain challenges in accepting the same role for very young and untrained students in the earlier years of engineering. There may be difficulty in finding resources for heavy projects.

Because the components required for such a project may involve substantial expenditures. And if there are too many such projects in curriculum there may be difficulty for the institute to provide the necessary resources; and obviously there is a heavy load on the faculty, so they may fear this overload. And the faculty needs to ensure that the students focused on the process as well as the product. This would require substantial amount of effort from the faculty side also.

And managing student conflicts and expectations also may impose additional burden on the faculty's time and capabilities. These are all the challenges that faculty face, when project based approach to instruction is adopted on a fairly, reasonably large scale in any engineering curriculum.

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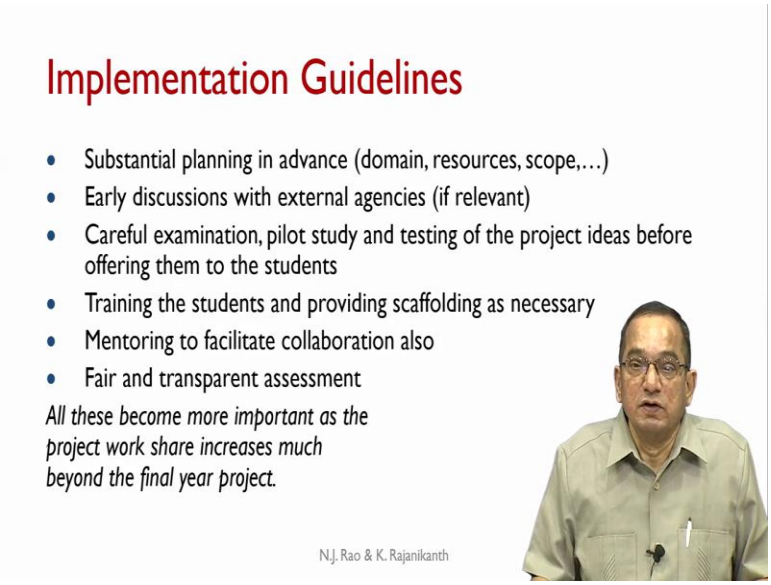

While there is no unique solution to solve these problems, certain general implementation guidelines have emerged over the recent years based on the experiences in several institutes. Their first key point is that substantial planning in advance is required if this approach is to succeed. The domain from which the projects are to be given; the resources which are required in order to successfully implement the projects, the scope to which the projects must be constraint; all these issues must be planned up front.

Early discussions with external agencies is required if the project is to be conducted with the collaboration of the external agencies. The external agencies could be industries or they could be other organizations working in local communities. In all cases early discussions are required to establish the framework and to make it systematic.

Careful examination, pilot study and testing of the principle ideas before offering them to the students may also be required. If an untested idea is being tried and if this leads to a failure, then the consequences for the students may not be that acceptable to the institute. Training the students and providing scaffolding as necessary is also important. Mentoring to facilitate collaboration also is extremely important.

This is although more important for the first year students. Fair and transparent assessment must be there to ensure that students feel that the project work is really helpful for them. All these

become more important as the project work share increases much beyond the final year project. In other words, when the institutes adopt project based approach to instruction.

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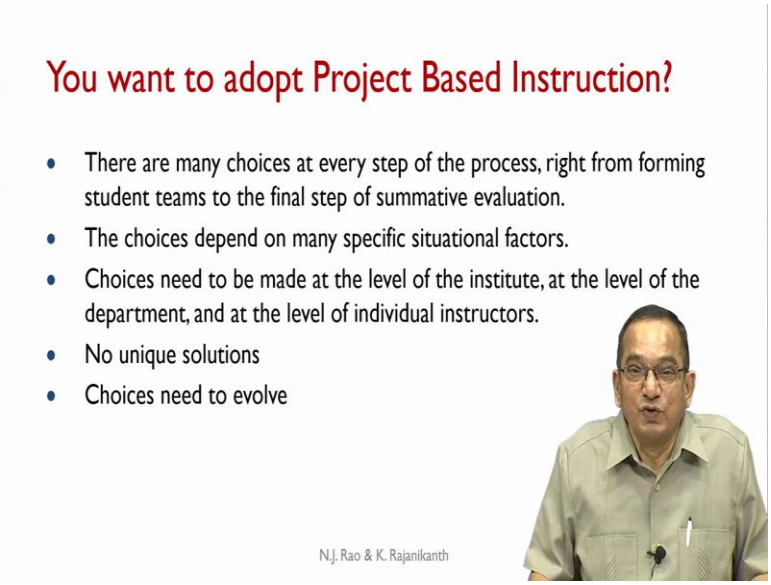

You want to adopt project based instruction? There are many choices at every step of the process, right from forming student teams to the final step of summative evaluation. The choices depend on many specific situational factors, contexts that are unique to your institute.

Choices need to be made at the level of the institute, at the level of the department and at the level of individual instructors also. There are no unique solutions; choices need to evolve over a period of time. You must take your specific, unique situational factors into account; while developing solutions for all these problems.

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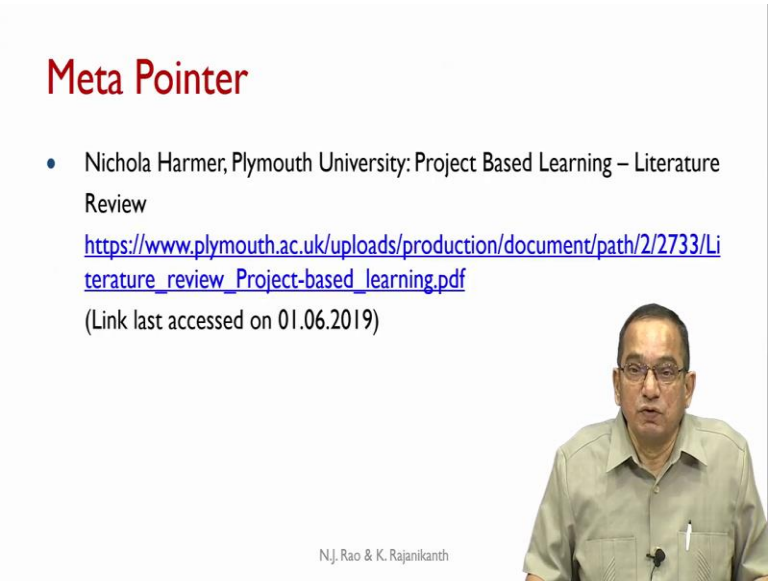

This is one good reference that you can use, Nichola Harmer, Plymouth University: Project Based Learning – Literature Review. There are many other links available, but this is a Meta pointer and this contains link to several other useful articles.

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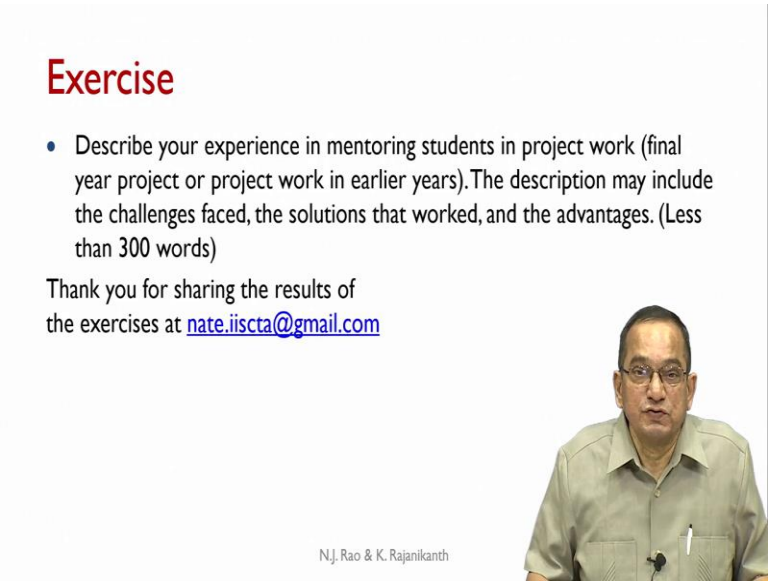

An exercise for you – Describe your experience in mentoring students in project work (final year project or project work in earlier years). The description may include the challenges faced, the solutions that worked, and the advantages. Please confine your written response to 300 words. Thank you for sharing the results of exercise at nate.iiscta@gmail.com.

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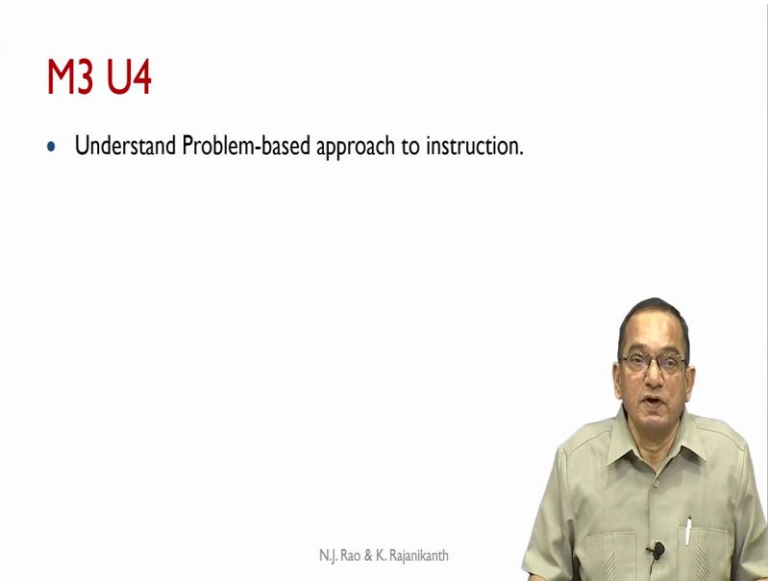

In the next unit we will understand the problem based approach to instruction. Another approach that is being trade by several institutes to address the emerging challenges of engineering education. Thank you.