NBA Accreditation and
Teaching – Learning in Engineering
(NATE)
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Lecture 21
Computing PO and PSOs Attainment

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Greetings, welcome to module 1, unit 20 on Attainment of POs and PSOs. In the earlier unit, we understood how to set targets and compute the attainments of course outcomes and close the quality loop at the course level.

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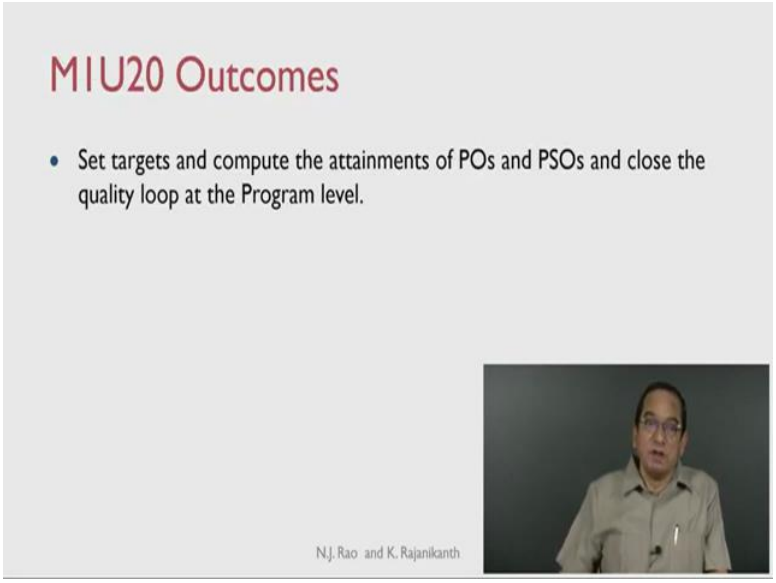

In this unit, we will look at setting the targets and computing the attainment of POs and PSOs and closing the quality loop at the program level. So the outcome for this unit is, set targets and compute the attainments of POs and PSOs and close the quality loop at the program level.

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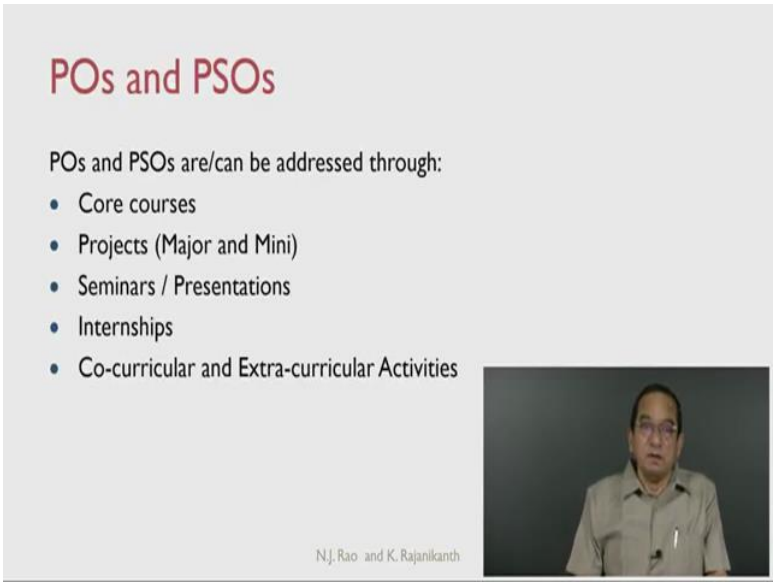

We already have seen that POs and PSOs are addressed through core courses, projects both major and mini, seminars, presentations, internships, co-curricular and extra-curricular activities in which all the students participate. Predominantly it is the courses which contribute to the attainment of POs and PSOs, but there are other important activities like projects, seminars, which contribute to the attainment of POs and PSOs.

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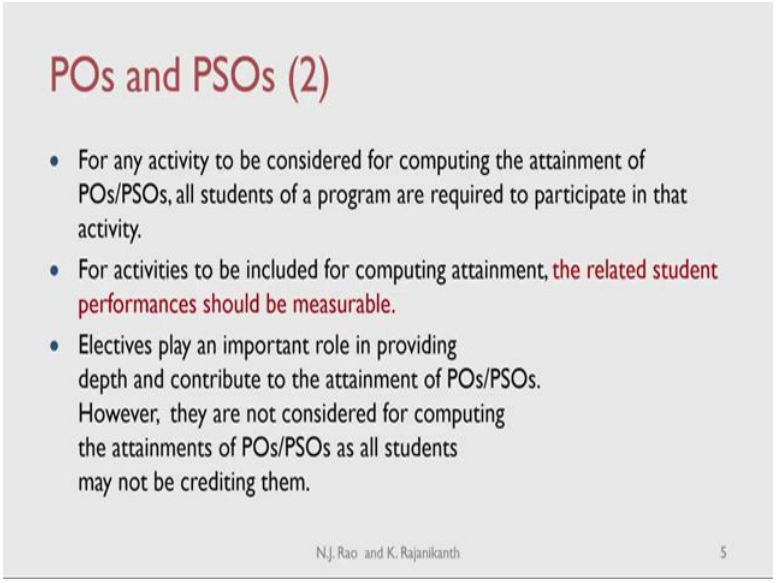

For any activity to be considered for computing the attainment of POs and PSOs, all students of a program are required to participate in that activity. This is an extremely important requirement and that is how even though electives play an important role in providing depth and contributing to the attainment of POs. Their attainments are not included in computing the attainment of POs and PSOs.

Electives are important, however, they are not consider for computing the attainments of POs and PSOs, as all students may not be crediting them. For activities to be included for computing the attainment, the related student performance should be measurable, this becomes important when we consider co-curricular and extra-curricular activities. Even if all the students are participating in these activities, in order to consider them in computing the attainment of POs and PSOs.

We must have appropriate rubrics through which their performance is measured and quantified, thus we need to have two considerations, all the students must participate in that activity and their performance must be measured. In such cases, we can consider that activity for computing the attainment of POs and PSOs.

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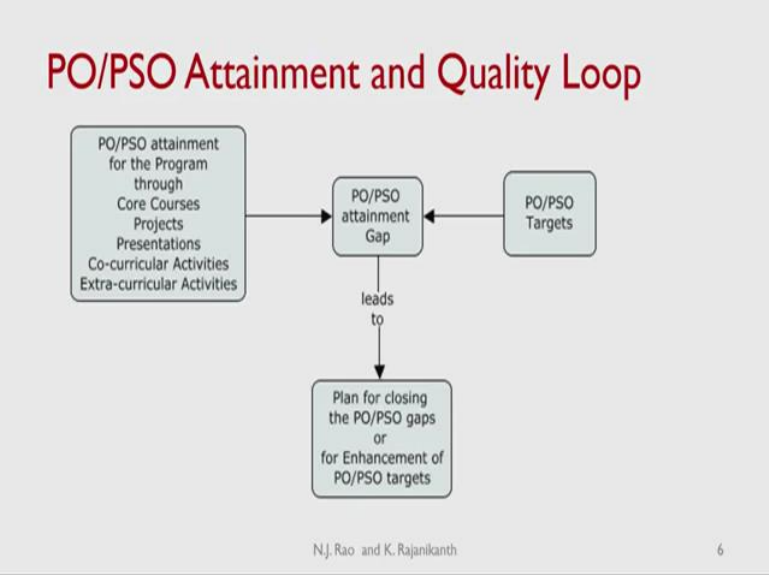

This figure depicts the broad process of PO, PSO attainment and closing the quality loop at the program level. PO, PSO attainment for the program through core courses, projects, presentations, co-curricular activities, extracurricular activities, seminars, all such activities that leads to the PO, PSO attainment. And initially we set targets for the attainment of POs and PSOs, comparing the targets and attainments we determine the PO, PSO attainment gaps.

This analysis leads to either plans for closing the PO, PSO gaps, are for enhancement of the PO, PSO targets. If the attainment is greater than or equal to the target, then the targets are enhanced, if the attainment lags behind the target, plans are made for closing the attainment gap.

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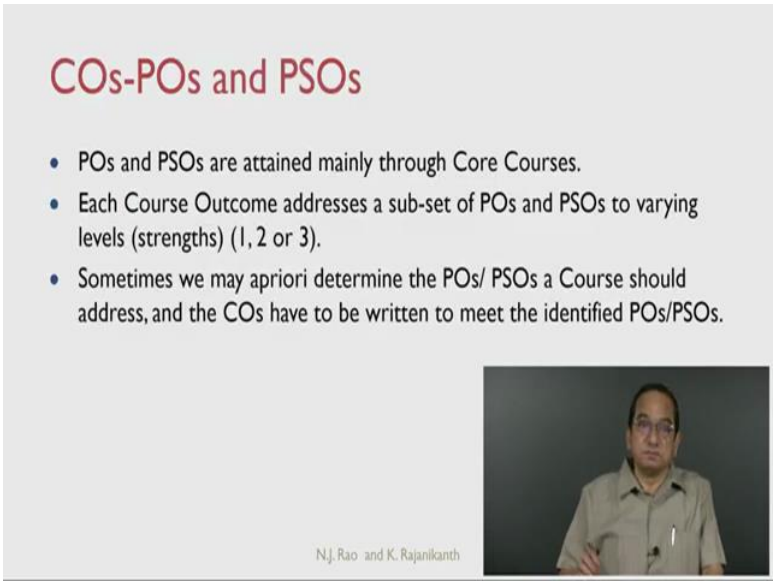

POs and PSOs are attained mainly through core courses. Each course outcome addresses a subset of POs and PSOs to varying levels or strengths. These strengths are characterized into 3 levels as per NBA level 1, level 2 or level 3. Sometimes we may apriori determine the POs, PSOs a course should address and the COs may have to be written to meet the identified POs and PSOs.

This may happen when the department decides that a particular PO is not being addressed adequately by the curriculum and hence, decides to address that particular PO through a specific course.

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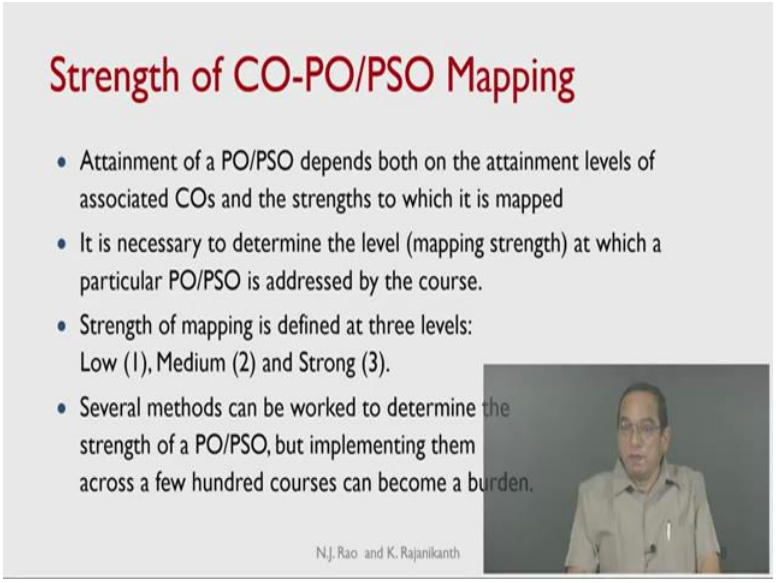

The strength of PO, PSO mapping to the COs needs to be determined, because attainment of a PO or a PSO depends both on the attainment levels of the associated COs and the strengths to which it is mapped. The higher the attainment of a CO, the higher will be the attainment of the associated PO.

The stronger the mapping strength between CO and PO, the stronger will be the influence of that CO on that particular PO, thus the attainment of a PO or a PSO depends both on the attainment levels of the CO and the strength to which it is mapped. So, it is necessary to determine the mapping strength between a CO and the relevant POs and PSOs. The mapping strength as per NBA has 3 levels, 1 is low, 2 is medium, and 3 is strong.

Several methods can be worked to determine the strength of the PO, PSO mapping, but implementing them across a few hundred courses can become a burden. So, once again, it is convenient if the entire Institute follows one common method of determining the strength of mapping between a CO and a PO.

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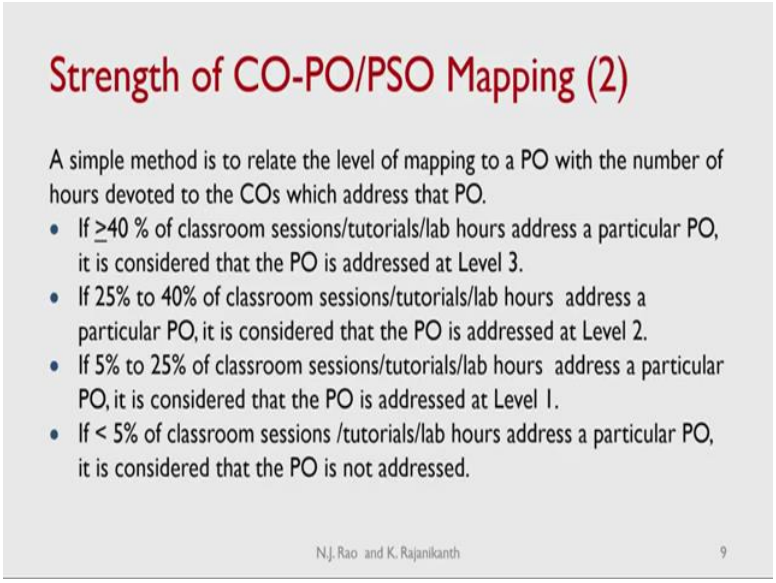

One simple method is to relate the level of mapping to a PO, or PSO with the number of hours devoted to the COs, which address that particular PO that is taken as a whole. How many COs address a particular PO and how much time is spent on all these COs together? In other words, how much time is spent on content that is related to a specific PO?

If greater than 40 percent of classroom sessions, tutorials, lab hours address a particular PO, then it is considered that that PO is addressed at level 3. If between 25 percent and 40 percent of the classroom sessions, tutorials, lab hours addressed a particular PO, it is considered that the PO is a addressed at level 2. Between 5 percent and 25 percent it is considered as level 1.

If less than 5 percent of classroom sessions tutorials, lab hours addressed a particular PO it is considered that the PO is not at all addressed. There is nothing magical about these numbers of 40 percent, 25 percent, 5 percent and etcetera, it is just a reasonable value. Institute can adopt any other reasonable values, the value should be same across the Institute. IQAC after some brainstorming can arrive at certain suitable numbers to be used and the entire Institute can use the same numbers.

For example, a particular Institute may wish to say that it is considered that the mapping is at level 3, only when more than 60 percent of the classroom sessions tutorials, lab hours addressed a particular PO, it is perfectly fine. These are all subjective judgments and any reasonable numbers can be used, the only requirement is that the entered Institute must follow one single process.

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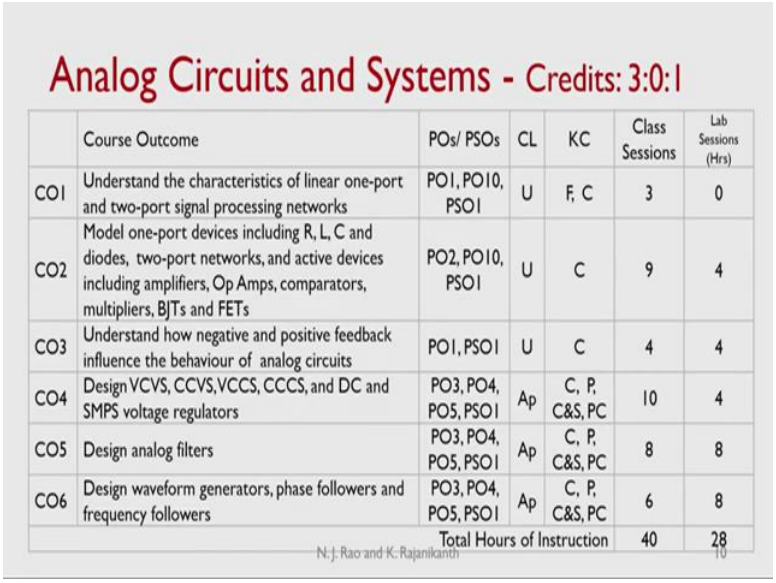

As an example, let us look at this course of analog circuits and systems with the credits of 3 colon 0 colon 1, 3 credits of theory and 1 credit of lab. So the course outcomes are given and the POs and PSOs addressed by that particular CO are also mentioned. You can see for example that CO 1 is related to PO 1, PO 10 and PSO 1 and it has 3 classroom sessions and there are no lab sessions.

Similarly, if you look at CO 6 it addresses the PO 3, PO 4, PO 5 and PSO 1. It has 6 classroom sessions and 8 laboratory hours. So, we determine what are the POs and PSOs addressed by a particular CO. Earlier we already have tagged the CO with the number of classroom sessions, tutorial sessions if they are, as well as lab sessions.

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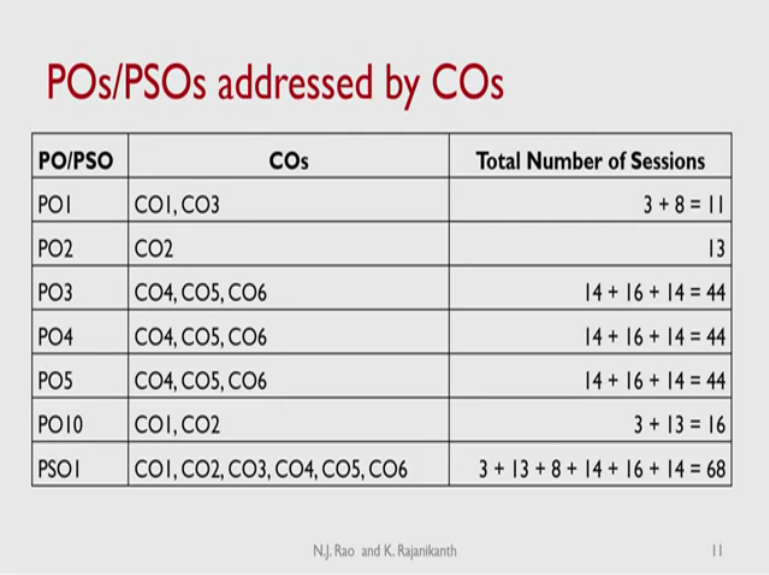

Now we determine for each PO which are all the relevant COs. Looking back at this table, we see that PO 1 is addressed by CO 1, CO 3, that is all. So, we make a table for each PO, which are all the COs which addressed that particular PO. PO 1 is addressed by CO 1 and CO 3, CO 1 has 3 sessions, CO 3 has 8 sessions, so the total number of sessions devoted to PO 1 would be 11.

Similarly PO 2 is addressed only by CO 2, the total number of sessions is 13, similar calculations we will do for PO 3, PO 4, PO 5, PO 10 and PSO 1. It is clear that the remaining POs are not addressed by this course at all. PO 6 to PO 12, PSO 2 they are not addressed by this course. So we determine how much time is being spent on content that is related to particular PO.

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Course – PO/PSO Mapping Strength

Number of Sessions Devoted	PO/PSO	Mapping strength
11 of 68 (16%)	PO1	1
13 of 68 (19%)	PO2	1
44 of 68 (65%)	PO3	3
44 of 68 (65%)	PO4	3
44 of 68 (65%)	PO5	3
16 of 68 (24%)	PO10	1
68 of 68 (100%)	PSO1	3

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POs/PSOs addressed by COs

PO/PSO	COs	Total Number of Sessions
PO1	CO1, CO3	3 + 8 = 11
PO2	CO2	13
PO3	CO4, CO5, CO6	14 + 16 + 14 = 44
PO4	CO4, CO5, CO6	14 + 16 + 14 = 44
PO5	CO4, CO5, CO6	14 + 16 + 14 = 44
PO10	CO1, CO2	3 + 13 = 16
PSO1	CO1, CO2, CO3, CO4, CO5, CO6	3 + 13 + 8 + 14 + 16 + 14 = 68

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And based on the number of sessions devoted we determine, what is the mapping strength between the course as a whole and that particular PO and PSO. For example, for PO 1, we are spending 11 hours out of 68 hours of total that means 60 percent of the classroom sessions and laboratory sessions are devoted to PO 1, so, we claim the mapping strength is 1.

Similarly, the mapping strength is 1 for PO 2, for PO 3, PO 4 and PO 5 the mapping strength is 3, because 44 sessions out of a total of 68 sessions that means 65 percent of the sessions are devoted to those POs, so, the mappings strength is 3. For PSO 1, the mapping strength is again 3, 100 percent of the sessions are devoted to PSO 1. That is how we determine the mapping strength between the course and the POs and PSOs.

Once we determine the mapping strength like this, the same number applies to individual CO, PO mappings that means that once we say that the mapping strength of the course to PO 1 is 1, CO 1 PO 1, CO 3 PO 1, the mapping strength will be 1 each. CO 2 PO 2, mapping strength will be 1, CO 4 PO 3, CO 5 PO 3, CO 6 PO 3, the mapping strength will be 3, this how the mapping strengths are plotted in the table.

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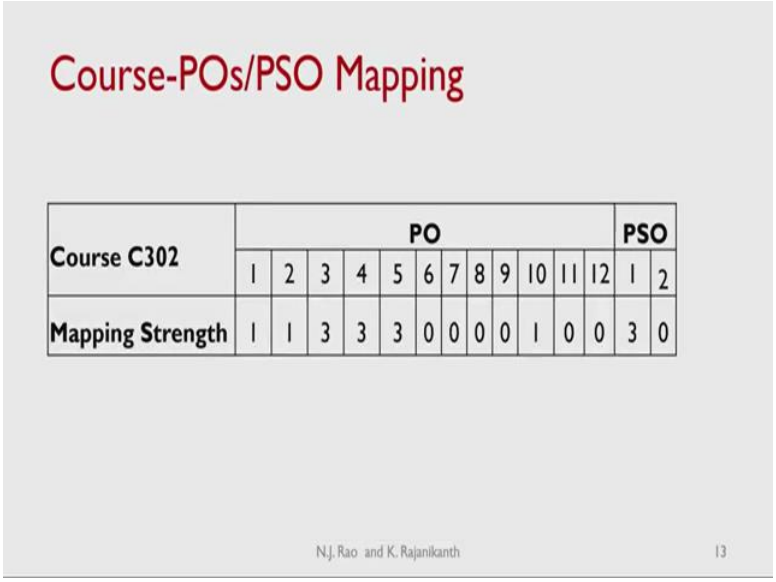

Finally, we get one single line indicating, what is the mapping strength between this course and POs and PSOs, we see that there is a mapping between this course and PO 1, PO 2, PO 3, PO 4, PO 5, PO 6, 7, 8, 9, 10, 10 there is a mapping strength of 1, 11, 12 again it is 0 between this course and PSO 1 the mapping strength is 3, between this course and PSO 2 the mapping strength is 0.

So, that is how we determine the mapping strength between the course and the POs and PSOs. That means that this course contributes to the attainment of POs 1, 2, 3, 4, 5 and 10 and PSO 1, it does not contribute anything to the attainment of the remaining PSOs or POs.

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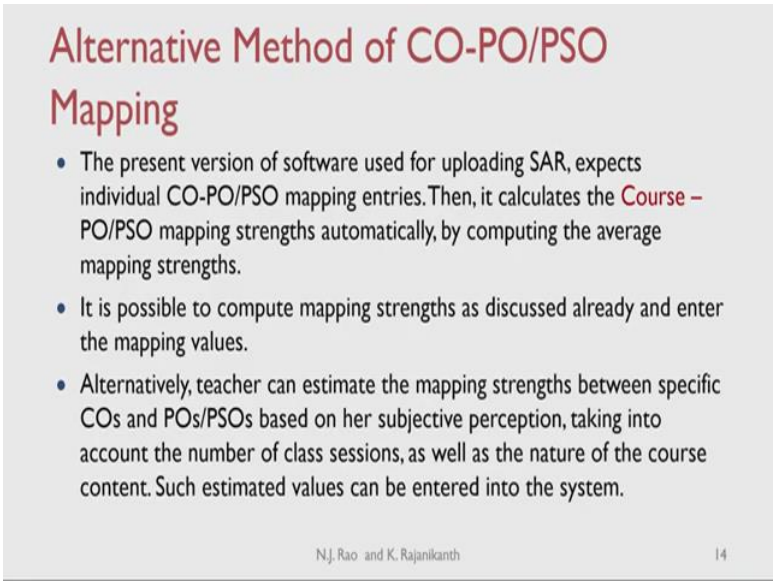

There is an alternative method of CO, PO, PSO mapping. The present version of the software used for uploading the SAR expects individual CO, PO, PSO mapping entries. Then it calculates the course PO, PSO mapping strengths automatically by computing the average mapping lengths, column wise.

It is possible to compute the mapping strength as discussed already and enter these mapping values. Alternatively, teacher can estimate the mapping strengths between specific COs and POs or PSPs based on her subject to perception, taking into account the number of class sessions as well as the nature of the course content. Such estimated values can be entered into the system.

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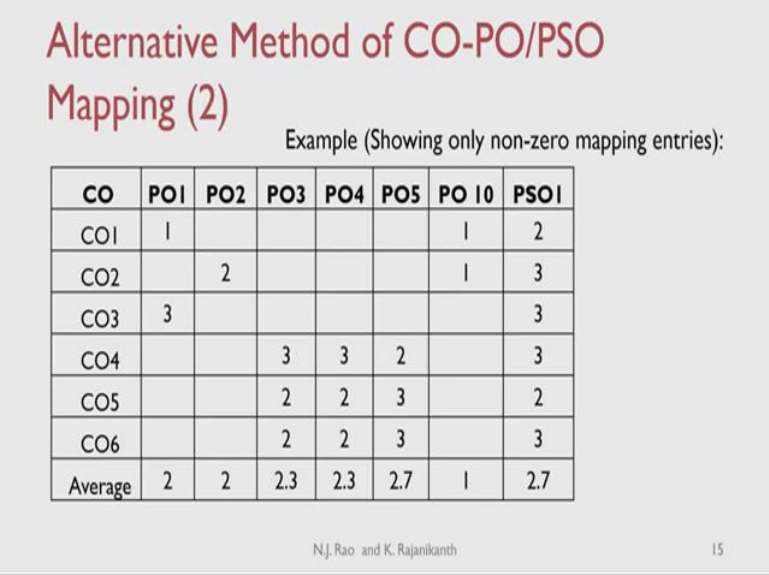

CO	PO1	PO2	PO3	PO4	PO5	PO 10	PSO1
CO1	1					1	2
CO2		2				1	3
CO3	3						3
CO4			3	3	2		3
CO5			2	2	3		2
CO6			2	2	3		3
Average	2	2	2.3	2.3	2.7	1	2.7

This is an example which shows only the non-zero mapping entries, the mapping strength between CO 1 and PO 1 is estimated as 1 by the teacher. Now how the teacher estimates that the mapping strength between CO 1 and PO 1 is 1, it is her subject to perception regarding the content that is related to CO 1 and the nature of PO 1, she may also take into account the number of classroom sessions devoted to CO 1.

But, ultimately it is the perception of the teacher and the teacher must be able to justify, why this mapping value is considered as correct by her. So, teacher enters CO 1, PO 1 mapping as 1, CO 3 PO 1 mapping as 3 and no other CO is mapped to PO 1 and thus the average mapping strength to PO 1 if you see, it is 1 plus 3 divided by 2, which is 2.

This calculation is done automatically by the tool, because that is how the tool works today, futures versions may change at the time of uploading the SCR, one has to look at what are the specific features of the software and adapt the processes accordingly. Similarly, teacher enters the mapping strengths between other COs and POs, and the system automatically calculates the average mapping strengths.

Thus according to the tool, the course has a mapping strength of 2 with respect to PO 1, 2 with respect to PO 2, 2.3 with respect to PO 3, 2.3 with respect to PO 4, 2.7 with respect to PO 5, 1 with respect to PO 10 and 2.7 with respect to PSO 1. Notice that fractional values are quite possible, because it computes the average column wise. For example, for PO 3, the mapping strengths are 3, 2 and 2, so the average value is 2.3 fractions are possible.

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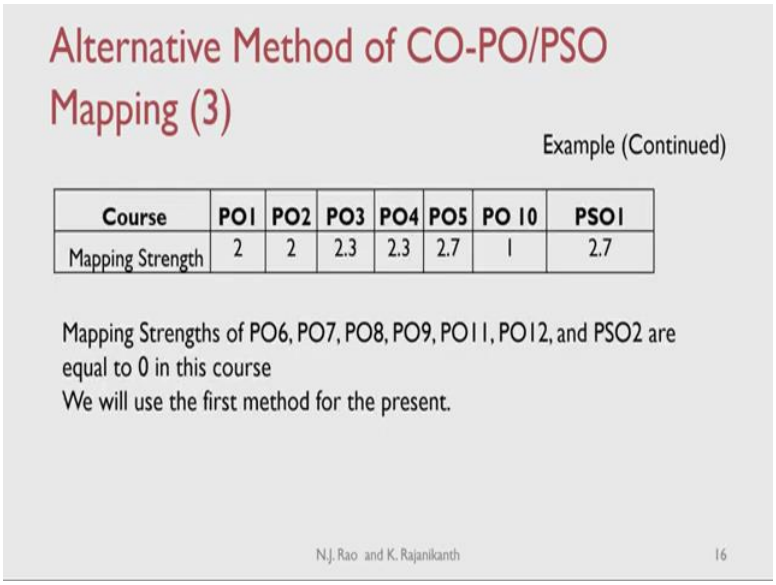

So, based on this alternative method if you do, the mapping strengths would be that 2, 2, 2.3, 2.3, 2.7 and to PO 10 it is 1 and to PSO 1 it is 2.7, because here we are showing only the non-zero values. The mapping strengths to PO 6 to PO 12 and PSO 2 are equal to 0 in this course. In the rest of the module, we will use the first method. However, instructor is free to use the second method if the institute has a policy of using the second method.

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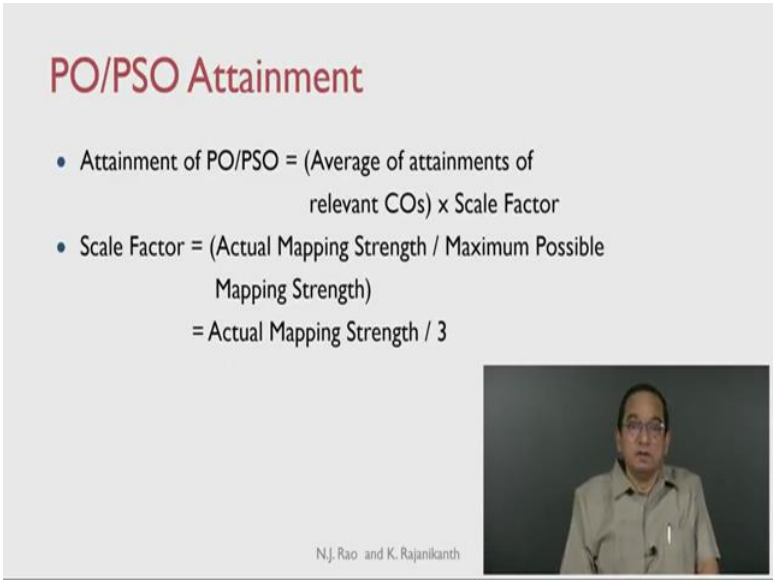

The actual attainment of a PO or PSO depends both on the attainment of the relevant COs as well as a scale factor which depends upon the mapping strength. So, the attainment of a PO or PSO is equal to average attainment of the relevant COs, if there are 4 COs which are getting mapped to that PO, what is the average attainment of all those 4 COs? That is

multiplied by the actual mapping strength divided by the maximum possible mapping strength which is 3.

So, that is a scale factor. If the mapping strength is 3, then the average attainment of the relevant COs, becomes directly equal to the attainment of POs are PSOs. The lower the mapping strength, the lower will be the value attributed to PO or PSO.

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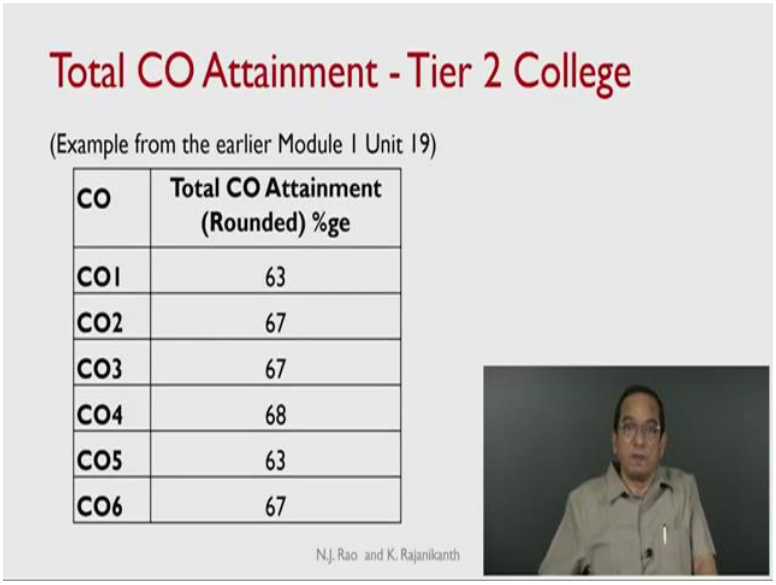

The total CO attainment from the earlier unit that is module 1, unit 19, we have copied the same values for a tier 2 college, these are the total CO attainments rounded percentages. CO 1 63 percent, CO 2, 67 percent and so on. We will use these values and the mapping strength to determine the attainment of PO and PSO.

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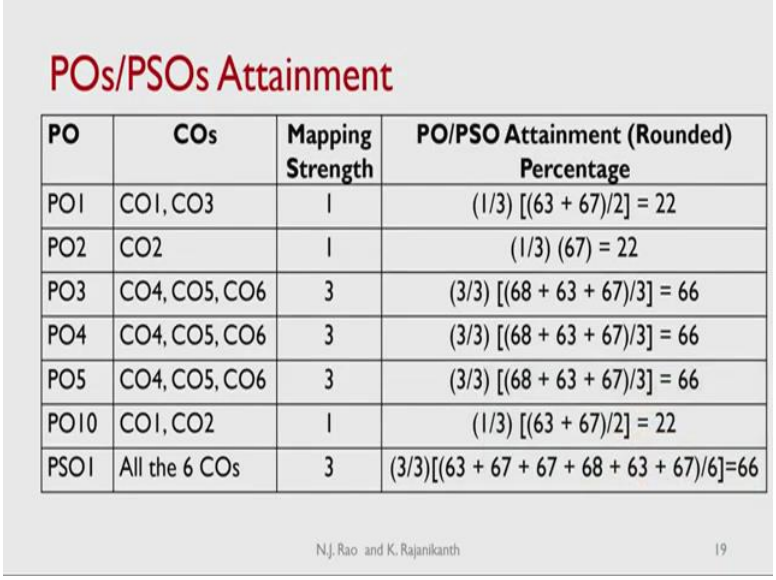

So, if you see the POs and PSOs attainment, PO 1 is addressed by 2 COs, CO 1 and CO 3, the mapping strength is 1. So first we determine, what is the average attainment because of the relevant COs? That means the average of the attainments of CO 1 and CO 3. We saw that CO 1 attainment is 63 and the CO 3 attainment is 67. So on the last column if you see, first we determine the average, 63 plus 67 divided by 2 that gives us a value.

Now this is modified based on a mapping strength, mapping strength is 1, so this average is multiplied by 1 by 3, giving us a rounded percentage of 22. In a similar way, the calculation for PO 2 shows that the attainment is 22 percent. If we look at the calculation of the attainment of PO 3 or PO 4 or PO 5 or PSO 1, we see that the scale factor is 1, because the mapping strength is 1 and the maximum possible mapping strength is 3.

And the actual mapping strength is also 3, so, the skill factor becomes 1. Thus the average attainment of the relevant COs becomes the attainment of that particular PO. For PO 3, the relevant COs are CO 4, CO 5 and CO 6 their average attainment of 66 becomes the attainment of PO 3, that is how the calculations are done for the attainment of POs and PSOs.

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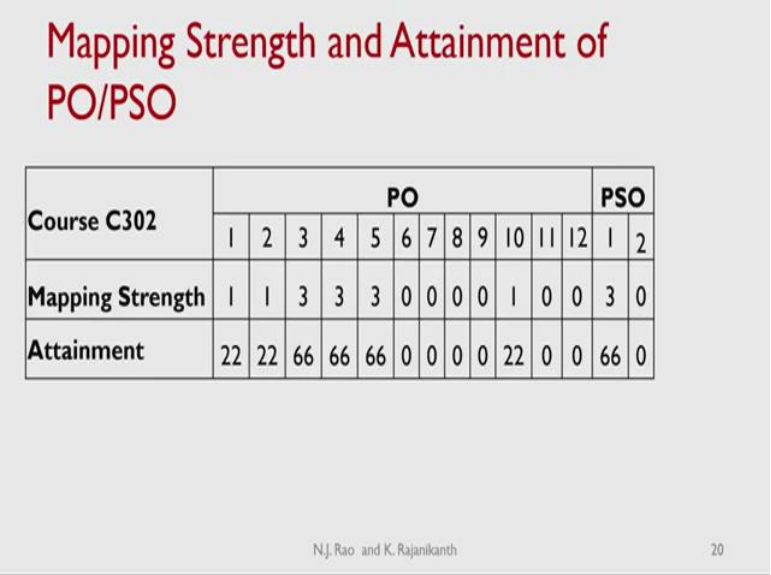

So, this summarizes the contribution of this particular course, towards POs and PSOs, one row shows the mapping strength another row shows the attainment. In other words, because of this course, the attainment of POs are 22 percent for PO 1, 22 percent for PO 2, 66 percent for PO 3 and so on this is the contribution from this one single core course.

We will have to determine the contributions from all other activities to determine the direct attainment of the POs and PSOs. So, if there are some 30 core courses we will have to determine the contribution from each course, there will be one such row corresponding to each core activity.

Whether it is a core course, or whether it is a core seminar or whether it is a project work that is a core activity or whether it is a co-curricular or extracurricular activity in which all students participate. Each core activity becomes one row in such a matrix.

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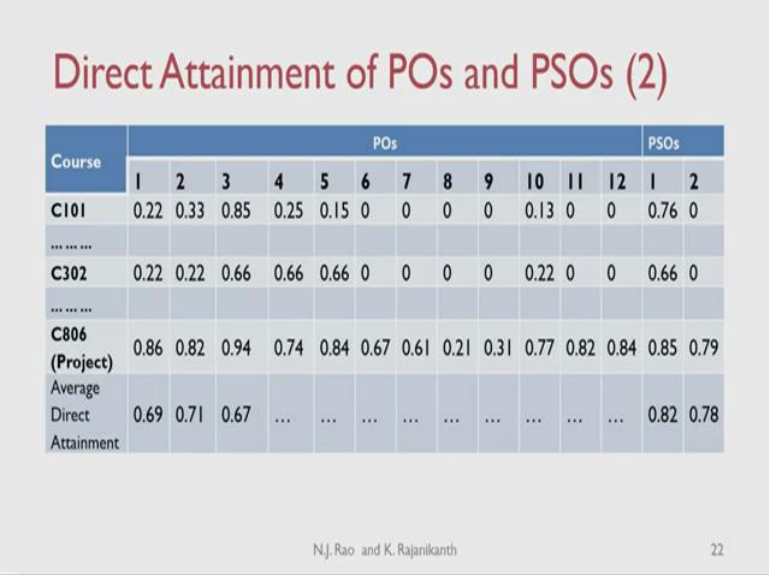

So, this is how a matrix will look, each course is shown and its contribution towards the attainment of POs and PSOs is also shown. So when we take the average of a column, it gives us the direct attainment of that particular PO or PSO. For example, if you look at PO 1, there are contributions from several core courses and other activities 0.22, 0.22, then 0.86 like that, the average is 0.69 that means the average direct attainment of PO 1 is 0.69.

Similarly, the average direct attainment of PO 2 is 0.7, similarly, we calculate the average direct attainments of all the other POs as well as PSOs. We can see that the average direct attainment of PSO 1 is 0.82, the average direct attainment of PSO 2 is 0.78. These calculations are also done automatically by the tool at present.

The present software through which SCR is uploaded does this average calculations automatically, it takes the number of non-zero entries in a column as the denominator and determines the average and calculates and outputs that value automatically.

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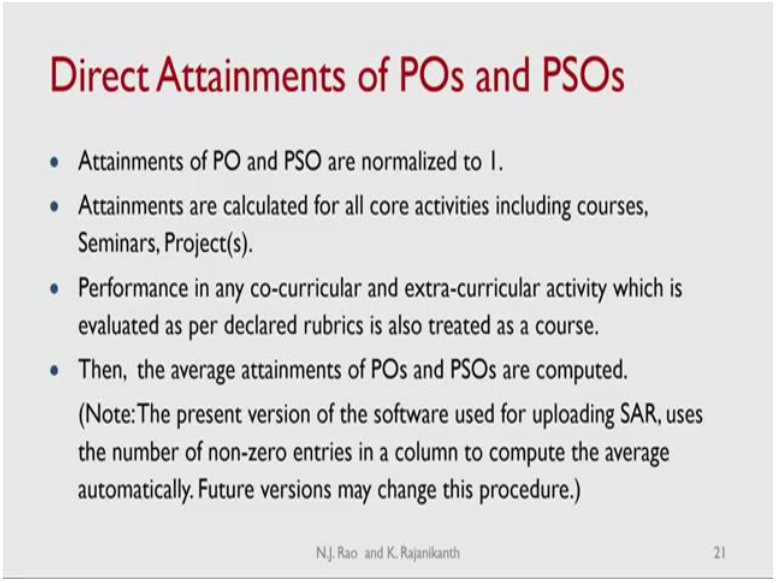

We can show the attainments of POs and PSOs normalized to 1, because it becomes easier to understand. Attainments are calculated for all core activities including core courses, seminars projects, performance in any co-curricular and extracurricular activity, which is evaluated as per declared rubrics is also treated as a course then the average attainment of POs and PSOs are computed.

As I just now mentioned, the present version of the software used for uploading SCR, uses the number of non-zero entries in a column to compute the average automatically. Futures versions may change this procedure and if the procedure is changed, the institute has to adapt to that procedure that is how the direct attainment of POs and PSOs is computed.

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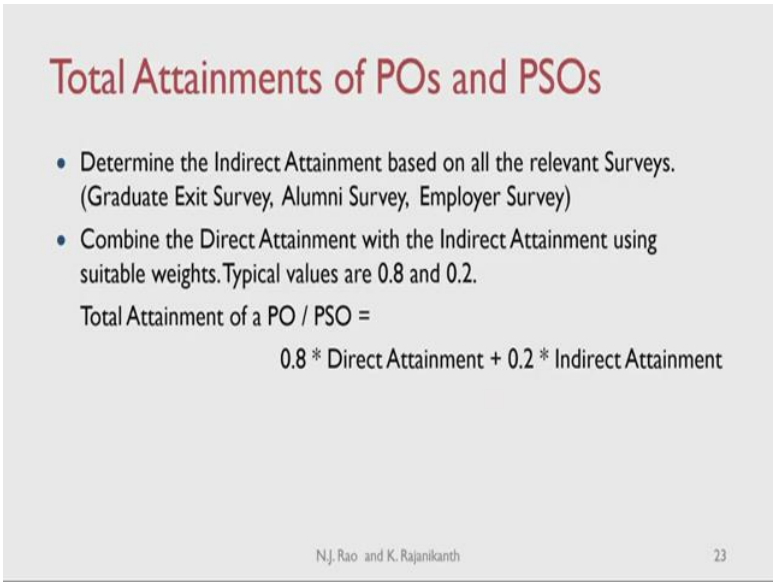

The total attainment of POs and PSOs is computed using the direct attainment as well as indirect attainment which is based on the relevant surveys. The indirect attainment is computed based on graduate exit survey, alumni survey and employer survey. We look at the details of how these surveys are conducted and how the data from these surveys is used to determine the indirect attainment in a later unit.

Here, we are assuming that these surveys are used to determine the indirect attainment of the POs and PSOs. The direct attainment is combined with indirect attainment using suitable weights. Typical values used by most of the institutes at present are 0.8 and 0.2. Thus the total attainment of a PO or PSO will be computed as 0.8 times direct attainment plus 0.2 times indirect attainment.

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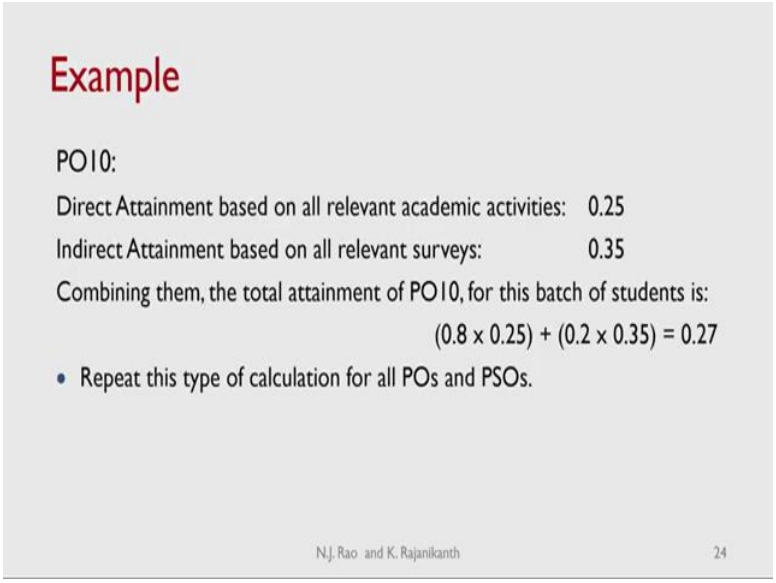

This is one example calculation for PO 10. Direct attainment based on all relevant academic activities, which means all the core courses which map to PO 10, all the other activities which map to PO 10 including project, seminars, co-curricular, extracurricular activities, based on the performance of students in all these activities, the direct attainment has been computed as 0.25, normalized between 0 and 1.

Indirect attainment based on all relevant surveys was determined to be 0.35. Combining them, the total attainment of PO 10 for this batch of students will be 0.8 multiplied by 0.25 plus 0.2 multiplied by 0.35 is equal to 0.27. This type of calculation has to be repeated for every PO and PSO.

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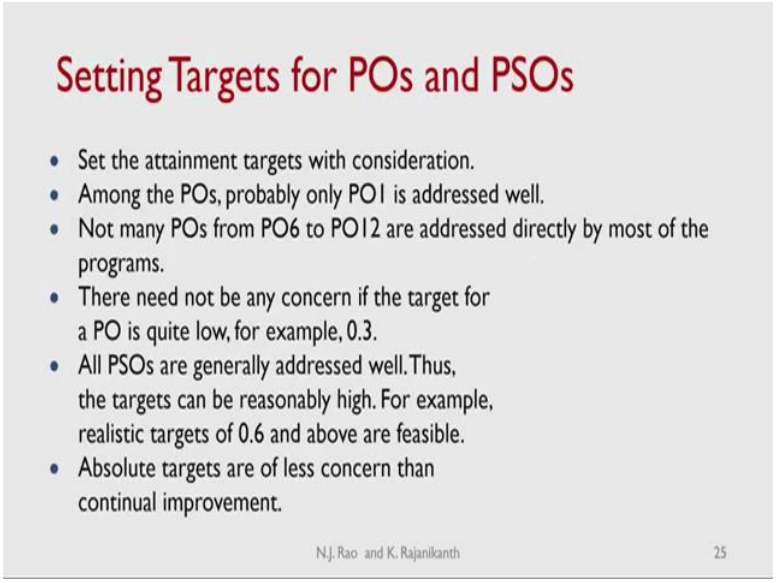

Then we need to look at setting a targets for POs and PSOs. There is no unique method or prescribed method for setting the targets for POs and PSOs. It is the perception of the department regarding various contextual factors, like the quality of the student intake, the quality of the resources available, performance history of the students, these are all the issues which the department has to take into account and set reasonable targets.

So set the attainment targets with consolidation. Among the POs, probably only PO 1 is really addressed well by most of the courses not many POs from PO 6 to PO 12 are addressed directly by most of the programs. There need not be any concern, if the target for a PO is quite low, for example 0.3, particularly tier 2 institutes will have difficulty in attaining some of the POs, because most of the curriculum do not address those POs.

So the institute can set a modest target to begin with and as that level is achieved, it can aim for higher levels of attainment. So, a department does not have to have too much of worry if the target is set low. All PSOs, on the other hand are generally addressed 12, thus the targets can be reasonably high. For example, realistic targets of 0.6 and above are feasible for PSOs.

Because PSOs are developed based on the curriculum and typically, that means that PSOs are addressed well by the curriculum. So the program can hoped to achieve higher attainment levels. So values of 0.6 and above are quite feasible in most of the programs. In anyway, absolute targets are of less concern then continual improvement.

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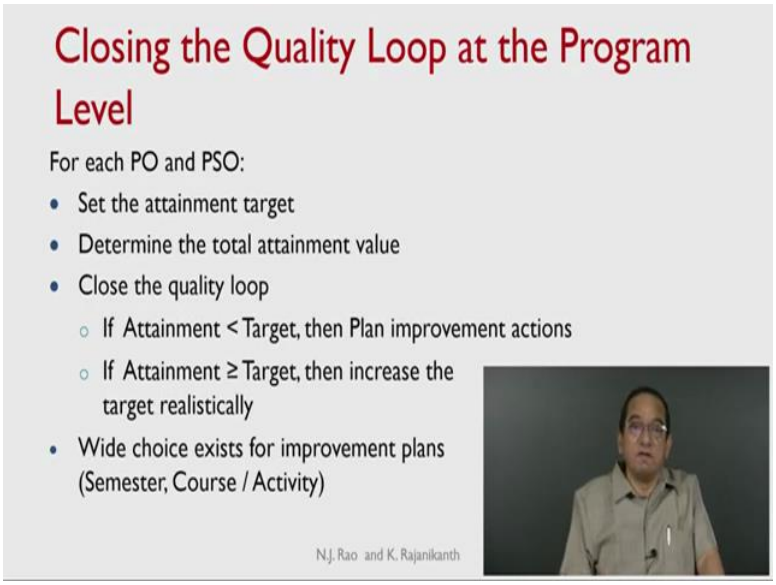

Closing the quality loop at the program level, this is the final stage for each PO and PSO we have set the attainment target, we determined the total attainment value, then we need to close the quality loop at the program level. If attainment is less than target, then plan improvement actions. If attainment is greater than or equal to target then increase the target realistically.

Wide choices exists for improvement plans because we are considering the improvement plans or the entire 4 year program. So, we can have the improvement plans in any particular year, any particular semester with respect to any particular activity.

So, there can be wide choice with respect to the semester, the course, the activity, where the improvements are being planned. When we look at the improvement plans for a specific course it is quite a limited choice, but when we look at improvement plans for PO or PSO the choice is quite wide.

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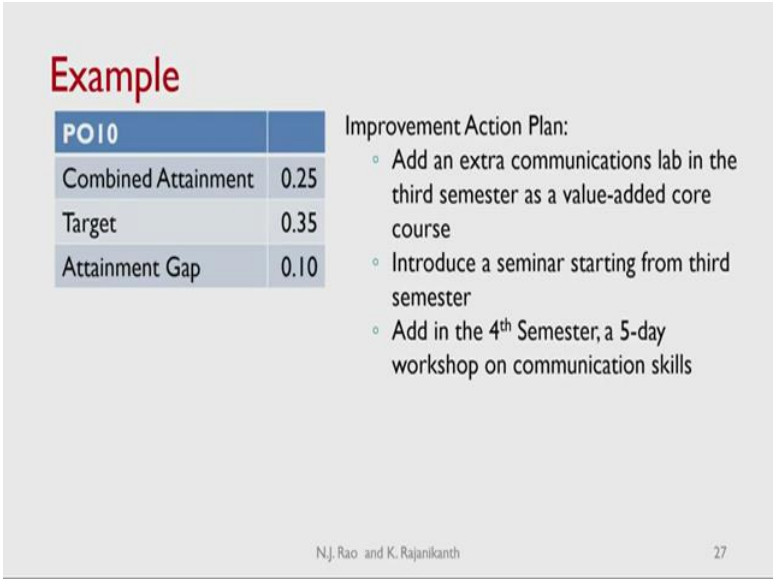

One example PO10, combined attainment is 0.25, the target was set as 0.35, so, there is a gap of 0.10. The improvement action plan says, add an extra communication lab in the third semester as a value added core course. So, this activity is being planned in the third semester. Introduce a seminar starting from the third semester, add in the 4^{th} semester a 5 day workshop on communication skills.

So, we can see that the improvement action plans are actually spread over both 3^{rd} semester as well as 4^{th} semester and this also means that this cannot be carried out for the next immediate batch. It has to be done only for the batch coming after that. These are all the considerations that a department must take into account while planning the action plans for improvement in the attainment of the POs and PSOs.

Again, if this involves any additional infrastructure, the department must prepare an estimate of the cost involved and submit it to the management. For example, if we are adding an extra communication lab that could cost. So some kind of an estimate would be required. And make the improvement plans again as specific as possible, avoid vague and fuzzy phrases like motivate the students better.

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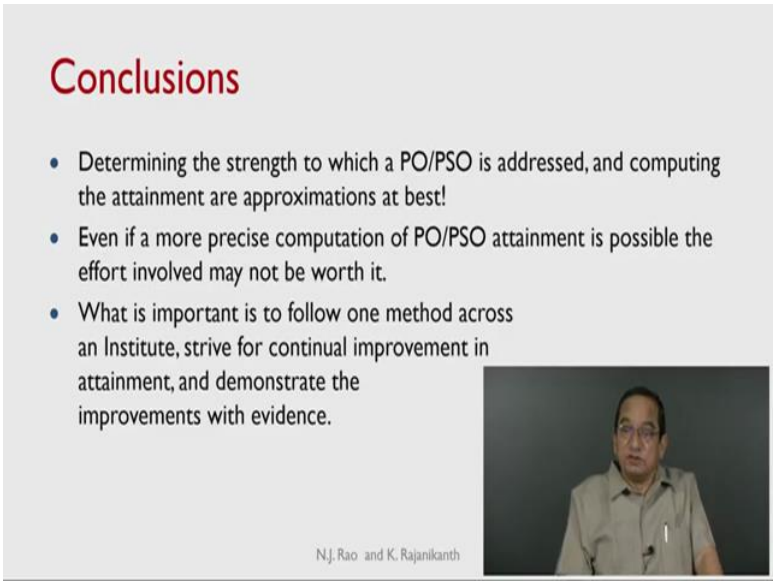

So, as conclusions we can say, determining the strength to which a PO or a PSO is addressed and computing the attainments or approximations at best, because we are looking at the computing the attainment of PO or PSO over a 4 year period based on several core courses and several other core activities. And each one depends on the mapping strength also, thus the final calculations anyway are approximations at best.

Even if a more precise computation of PO, PSO attainment is possible, the effort involved may not be really worth it. What is important is to follow one method across the institute, strive for continual improvement in attainment and demonstrate the improvement with the evidence. The core philosophy of NBA is that the department strives for continual improvements.

If we can demonstrate with evidence that such an improvement is happening, then that would show the quality path being pursued by the department that is extremely important, and in fact that is more important than the actual numbers.

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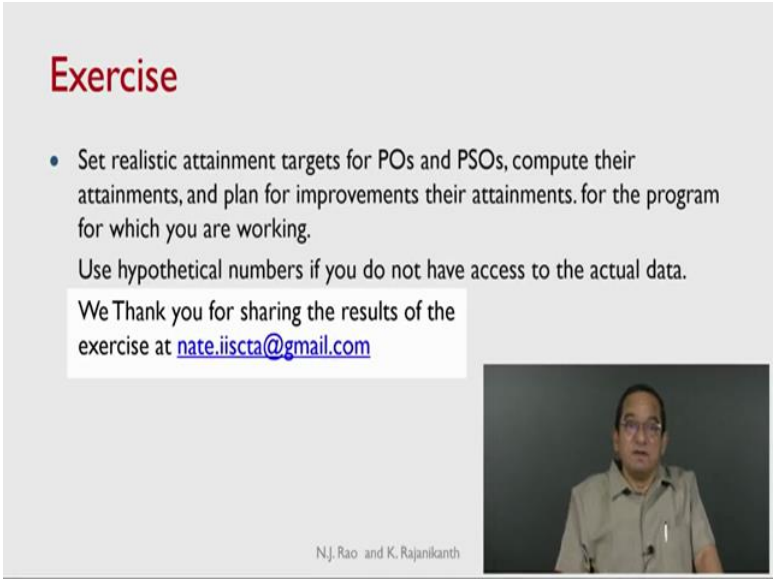

In exercise, set realistic attainment targets for POs and PSOs, compute their attainment and plan for improvements of their attainments for the program for which you are working. Again, use hypothetical numbers if you do not have access to the actual data.

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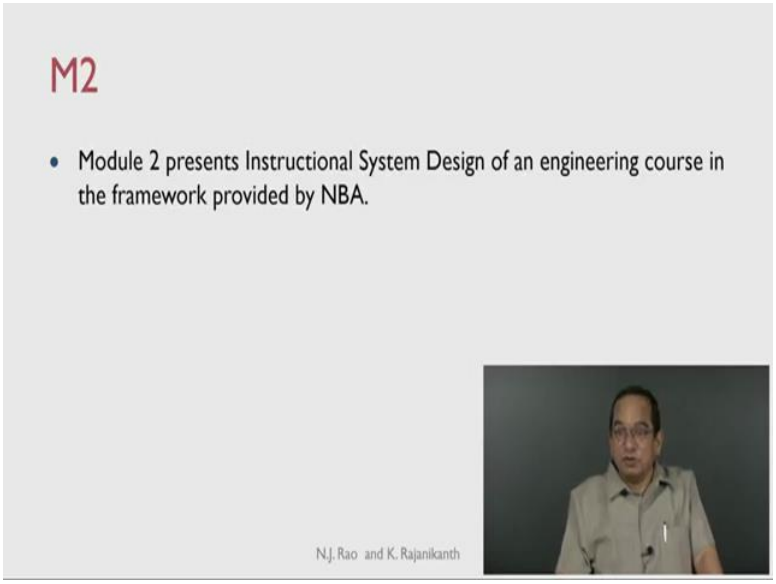

This concludes our module 1 and in the next module, we look at instruction system design for an engineering course in the framework provided by NBA. So that will be module 2. Thank you very much, and we will meet again with module 2. Thank you.