Design and Pedagogy of The Introductory Programming Course

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Lecture – 12
Pedagogy.0: Introduction and basic principles

Hello and welcome to the third sequence of lectures in the course on design and pedagogy of the introductory programming course. Our topic for today is pedagogy so a quick review of where we are.

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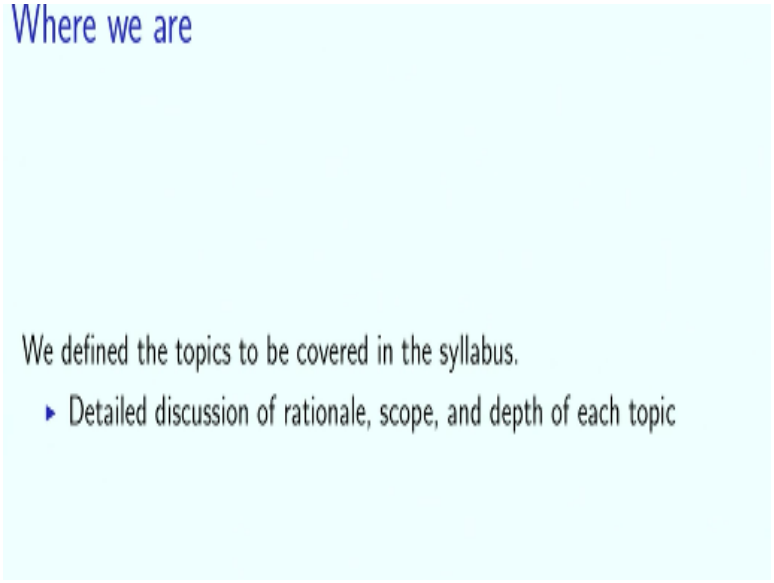

we have defined the topics to be covered in the syllabus in the last lecture and in the early lectures we have said why introductory programming is important and we have discussed some problems and some challenges in teaching this course. Now that we have defined the topics to be covered in the syllabus and we have done a detailed discussion of the rationale, scope and the depth of each topic.

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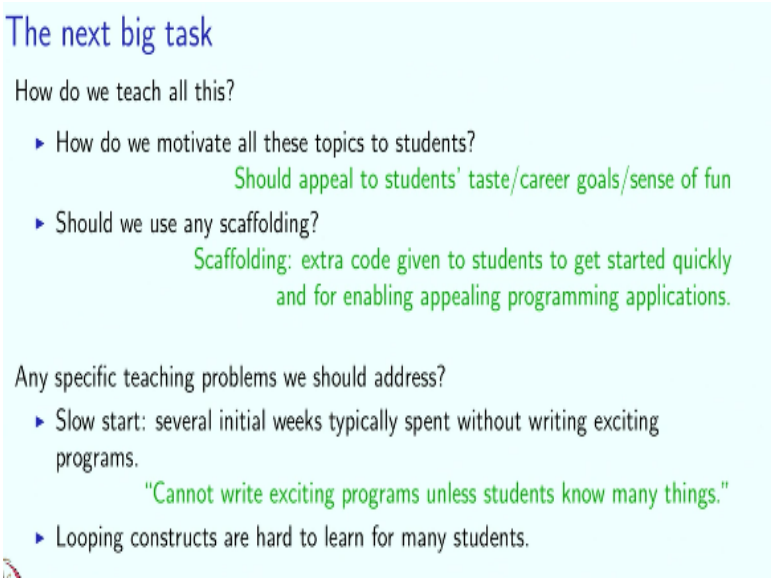

Our goal is to think about how do we teach all this. So, having a set of topics is quite different from the way we present them and of course the way we present them did have an effect or whether we can present these topics properly did have an effect on why we chose the topics and vaguely did not choose certain topics. However today we are going to go into detail in the teaching in the delivery how do we deliver all this material to students. So, the first question is how to be more to motivate all these topics to students.

And these topics should appear to student's taste, career goals and not only that also the sense of fun should be using the scaffolding. We have discussed scaffolding some time ago by scaffolding we mean extra code to be given to students to get started quickly. So, this is sort of like putting training wheels on a childrens bicycle. So, if you put training wheels the child can start cycling and the training wheels in fact help the child get the basic competency and even sometimes the child can learn to ride a bike by himself without anyone even helping.

So, can we have some scaffolding by our other students will be in good shape to play around and maybe learn a lot without us helping them too much. So, we could have scaffolding for the purpose of getting started quickly but the scaffolding can also be used to enable appealing programming applications. So, without scaffolding we are being limited to some set up applications if we throw in some code then maybe even be able to get good a richer set more interesting set of programs as examples in our lectures.

And also as assignments that we give to students. In addition, when we decide who to teach we can think about how the course has been taught earlier and what teaching problems have we noticed. So, one teaching problem that plagues this course is what might be called the slow start. So, typically several initial weeks gets spent without writing exciting programs. Now we may say that we cannot write exciting programs unless students know many things and that is true. However, that puts a big big damper on the enthusiasm that students have at the beginning.

They come into the course they are ready to go they have a higher energy levels and we have to somehow get them to work very quickly than some other problems that have been noticed are that looping constructs are hard to learn for many students and as we know looping is sort of a very basic programming idea. Iteration and recursion are two core elements of programming and looping is iteration and you want every student to master the looping game and of course recursion is hard to understand.

So, anything that we can do to go over these two obstacles seconds would be a good thing.

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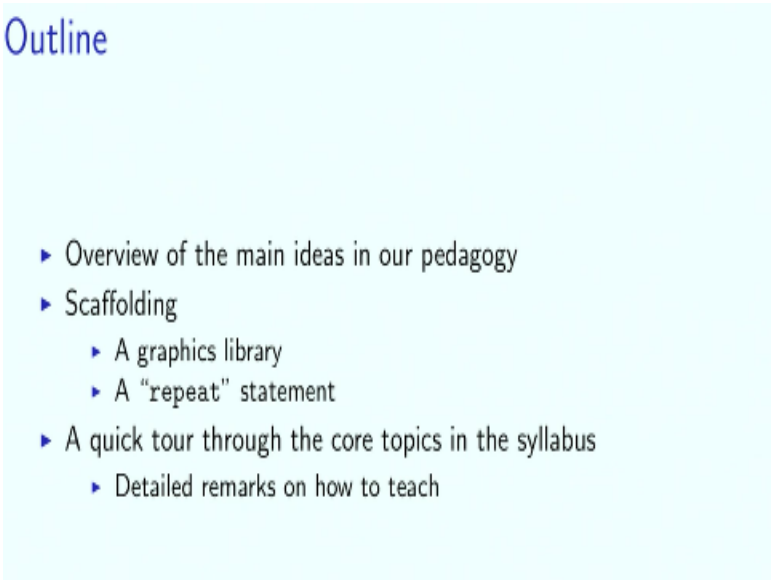

So, here is the outline of todays sequence of lectures so were going to talk about the main ideas in our pedagogy course. Then we are going to talk about the scaffolding were going to use the scaffolding is consisting is going to consist of a graphics library and so called repeat statement

then after that we really do a quick tour through the core topics in the syllabus. Well it is not going to be quick in the sense of it will talk a hour longer.

But it will be quick in the sense of the entire syllabus so you are going to cover the entire syllabus in it and talk about how specific topics could be taught. So, we will have detailed remarks and now on to some basic ideas in our pedagogy.

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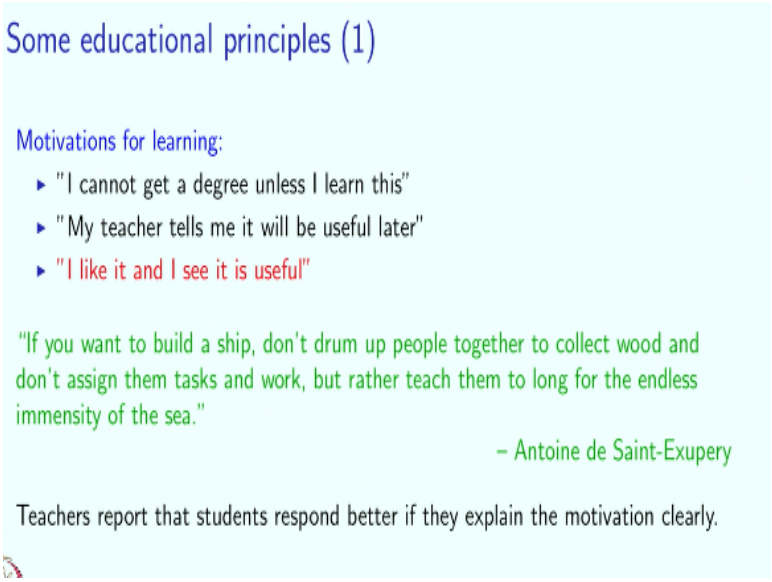

Now let us begin some education and principles. So, the first thing and the most important thing perhaps as far as learning is concerned is motivation. Students need to be motivated so if students do not want to learn if students do not see the point of learning then however the value to the rest of your teaching it is not going to sink in. If on the other hand students themselves want to learn then even if you are teaching for short their own energy will carry them through the material.

So, what can the motivations be for learning I cannot get a degree unless I learn this that could be even motivation. Those are the rules of the university another motivation is that my teacher tells me it will be useful later or the motivation as we have discussed before it could be that I like what my teacher is telling me and I see it useful it is not just useful that students respond to. Students may sometimes not know what is useful but students also respond respond to clever or somehow the students do have a sense of figuring out that look this idea is somehow deep.

Well, it is a bit of a learned ability but certainly students can figure out that this idea might be useful this idea seems to be powerful. So, if you tell students powerful ideas and useful ideas and also fun ideas students set up and start working on their own. Here is a quote that I quite like it says if you want to build a ship do not drum up people together to collect wood and do not assign them tasks and work. But rather teach them to long for the endless immensity of the sea. So, tell them what the payoff is going to be.

Do not tell them that you have to do this this this and this tell them what you are going to get out of all the hard work and then they will work hard. Now I have had this discussion about motivation with many teachers and there is that there is a college there is a university with which I consult and in one of the sessions I advised them that please please make sure tell your students why we are learning something and only then teach that and their teachers how reported to me that this strategy has changed the way students respond to them.

So, I am a firm believer in conveying motivation. So, whatever you teach there should be a lot of motivation given to students.

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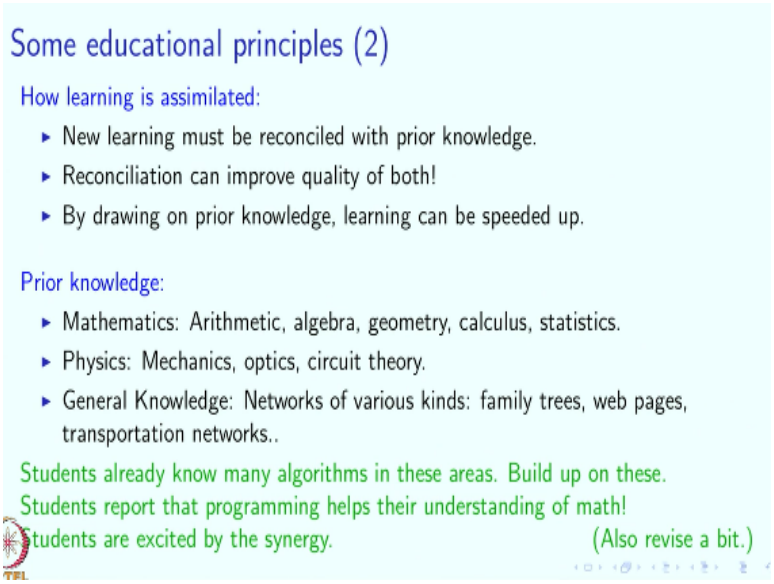

Okay some educational principles some more educational principles in this day let us think about how learning is assimilated. Students do not come to us as a blank slate in fact no human being is

a blank slate even a baby has some some likes likes and dislikes. And even a baby has some expectations so as far as we are concerned we could simply say that new learning must be reconciled with prior knowledge. So, new learning may contradict but to be seem to have a conflict with what has been learned before that is a problem.

New learning might boost what has learned before that is an advantage okay. So, if you can say or if you sort of alert students to the connections between what they have learned earlier and what they are learning now students can ask few questions about possible contradictions. And if the contradictions go of it or if the students somehow see that look the new idea of the so-called new idea that you are talking about is really an idea that they maybe saw in some other form in some other course.

Then that actually helps you but it also improves the quality of the learning of both. So, by drawing on prior knowledge learning can be speeded up and also qualitatively improved what kind of prior knowledge do our students have. Well they have learned a lot in mathematics arithmetic, algebra, geometry, calculus, statistics they have learnt a lot of physics and we have seen earlier that much of this learning is algorithmic. They have learned algorithms to solve various kinds of problems.

So, we certainly should try and connect whatever we do with this prior learning. Our students are somewhat mature they are adults, young adults and so they have a lot of late experience some amount of life experience I should say so they know networks of various kinds family trees, web pages these days these days everybody knows about internet they certainly know about transportation networks. So, somehow we should connect computer programming to all these areas.

If we do that then it will get assimilated much better so students build up on many algorithms in these areas so we should build up on these. And I have found that students actually say that when they learn programming it actually helps them in better understanding that the math that they planning to learn specifically this came about in connection with the topic of newtons method for finding roots. So, in the math course they had not really used it they are not really thought about

it a lot and when they learnt it again in computer programming course.

And by the way this is in the book that we are either referring to and it will be in the slides in some animated form if you choose to get the slides of the book so students say that my writing programs the quality of the math is actually improving and of course if you remind them that this topic about which you had writing the program has been studied earlier their programming motivation as well as well as the quality of the of the program that we write will get better. I think it is safe to say that students are excited by the connections of the synergy

Between various topics and of course I should warn you here that when you say that look you learned in that course students might also forget a little bit so you should think about revising a little bit if possible so not not to go over the entire lecture. But maybe just have a slide stating what they expect to know and giving the students a minute to assimilate what you expect and that should be that will often be enough for the student's memory to be jogged and you can start of moving from that.

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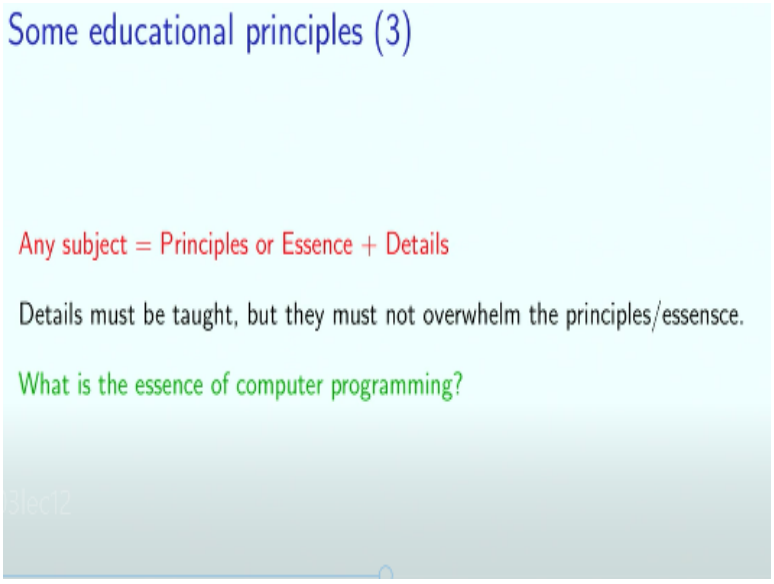

Another set of educational principles is that any subject consists of principles or essence and then there are lots of details. So, we have to teach each details but we have to do it in a manner that they do not overwhelm the principles or the essence. So, the principle is still stand out the student should still get all the details or maybe sometimes it works better if you do not discuss all

the details in the classroom. But you say look read this read the book and the book will tell you all the details but my job in the classroom is to hit the principles hit the high notes.

So, of course this requires us to figure out what is their essence of the subject that we are teaching what is the essence of computer programming. So, we should have that in mind and whenever you teach a topic it is useful to make this distinction what is what is the big idea what are the small ideas okay.

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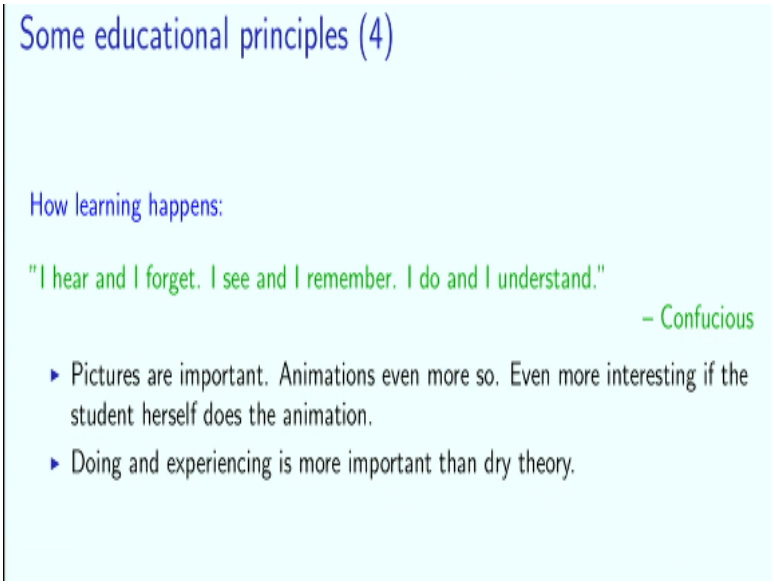

Then you can ask how does learning really happen so this is a quote I have told you before but this is such an important quote that I do not feel any hesitation in revising it. So, confucious says I hear and I forget, I see and I remember and I do and I understand. So, if you use the principles that are being taught you learn the best okay if you see them in action you learn the best. So, pictures should be there animation should be that even more interesting if the student herself does the animation.

So, we should get the students to themselves make the ideas that they are learning and generate pictures of it. So, if they see pictures it is more likely that they will remember what they were learning. So, again I do not mean I do not mean this in a frivolous sense I am not trying to say that we should turn everything into a game. But very often there is a geometric connection or

very often interesting problems arise out of geometrical considerations. After all of our student's science and technology measures.

So, in both these fields there is a very common practice of drawing graphs and explaining things for her pictures. So, I think that explained explanation via pictures this should get into our programming examples and the assignments that we give. So, I am really saying that some kind of graphics like scaffolding is will be very useful to have because that will help students remember more vividly whatever it is that we are looking. So, doing and experiencing is very important.

And of course we should give programming assignments for pretty much every principle that we want them to learn.

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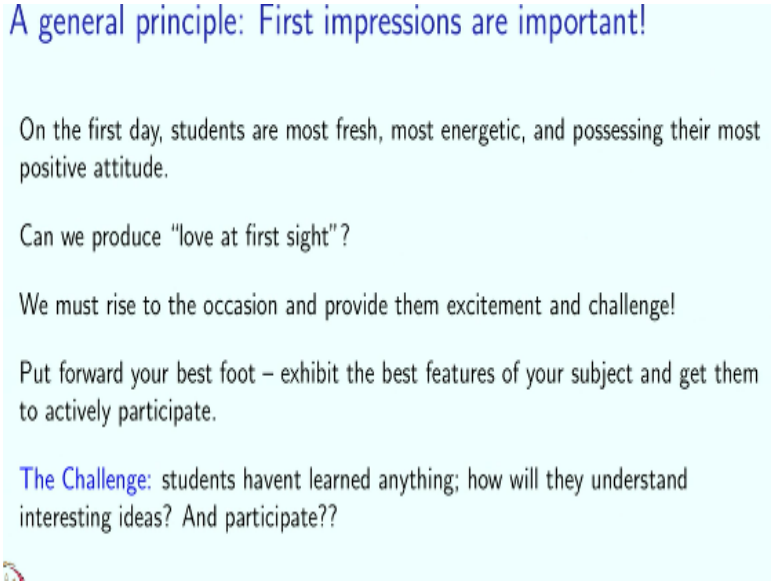

Then a principle from day to life first impressions are important. On the first day students are most fresh most energetic and possessing their most positive attitude. So, as the days goes on some irritants might crop up students might get busy students may just get a little tired because they have been working hard on other topics. And on your own topic as well so it is important to catch the students when they are most liveliest most attentive and which is the first day.

And get something exciting done on that day. Another way this is also an equally good way to

express what I want to see or hear can be produced love at first sight. So, love at first slight applies to living individuals but it also applies to living topics living subjects. Can we present computer science or computer programming in such a way that students fall in love with it. For this we must rise to the occasion and provide them excitement and also a challenge. I want to underline the word challenge over here.

Because we may think that our students are lazy or they are uninterested. But that I think is completely wrong I think if we nurture them properly I think they will want challenging things. So, they will want challenges which they can which they can rise to which they can overcome and overcoming the challenges will give them great pleasure and so we have to tell them on the first day itself show them not just tell them. Somehow show them that other subject is exciting and will provide them challenges which if they overcome.

And we will help them overcome they will get a lot of pleasure and a lot of satisfaction. So, what I am saying really is put forward your best foot on the first day. Exhibit the best features of your subject and get your students to actually participate of course this is not easy I mean our students have not learned anything at all when they come into a course on the first day. So, naturally there is a question how will they understand interesting ideas and perhaps it is just preposterous to say that we can get them to participate.

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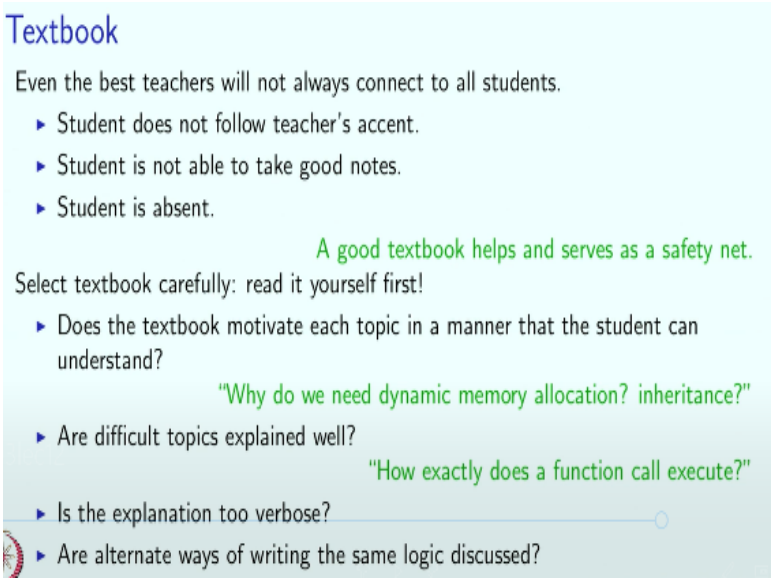

But were going to try and tell you how to do this I believe that textbooks are pretty important for pedagogy. I think there is a tendency of using slides and encouraging students to study from slides. I think slides and lectures are useful but they also have their limitations as I said a minute ago it is much better to get the details out of a book rather than getting every detail out in the classroom. But there are many other problems as well. So, for some reason or another even the best teacher will not always connect all students.

You may really be a great teacher but quite possibly 10% percent of the students may have some problem or other with you. It it could be as trivial as somehow they do not like your manner. But maybe they do not follow your accent so India is such a big country people all over the country have many many different accents and if you have I mean teachers maybe from one community students maybe from another community and it is not always easy to follow everyones accent. So, in that case having a book is very useful student may not be able to take good notes.

Actually many students have difficulty in understanding spoken English. So, because of that students may not follow even class at all. But if they have a good book they will be able to read it they will be able to read it add their own piss poor it several times look up the meaning of a word in the dictionary and they can do it in the privacy of their home. So, for this reason as well as for the difficulty in taking good notes I think a text book is really useful provided you sort of stick to the text book.

A student could be absent and then what then he or she talks to his or her friends but it is much better if he or she can refer to a book for the topic that could cover okay. So, essentially am I suggesting that a good textbook helps out and serves as a safety net okay. So, if everything else fails and the student is falling the student will fall of the safety net and not have any injury. So, the student should be able to go back and read the notebook.

If he or she for some other for some reason does not follow in class. Okay now the textbook should be chosen very carefully I have seen textbooks and it is clear that they have not been read there are really a large number of books in which the explanations are not good simply. So, here are the things that we too should have which you should look for does the textbook motivate

each topic in a manner that the student can understand. Not in the manner that look this is what experts think you should do in a manner in the language of the students.

Giving reasons that the students can understand so here are some typical things that you might want a book to tell you why do we need dynamic memory allocation why do we need inheritance. So, these questions are very valid questions which a textbook and a teacher must explain. So, there are some topics which are considered difficult are they explained well how exactly does a function call execute. So, this is something that is very puzzling okay how do the arguments get copied, do they even get copied.

Can we have variables with the same name and why so a very precise explanation of what goes on goes a long way towards clearing up the students doubts towards getting the student to understand exactly what happens then a function call executes okay. Sometimes the explanation is too verbose so you do not want that either. So, it is a tricky thing the textbook should also discuss alternate ways of writing the same logic. Because after all we are teaching the language to the student as well.

So, there may be there are several ways of explaining expressing the same logic and in different contexts context different ways might be more important more appropriate so the student should have a feeling for that.

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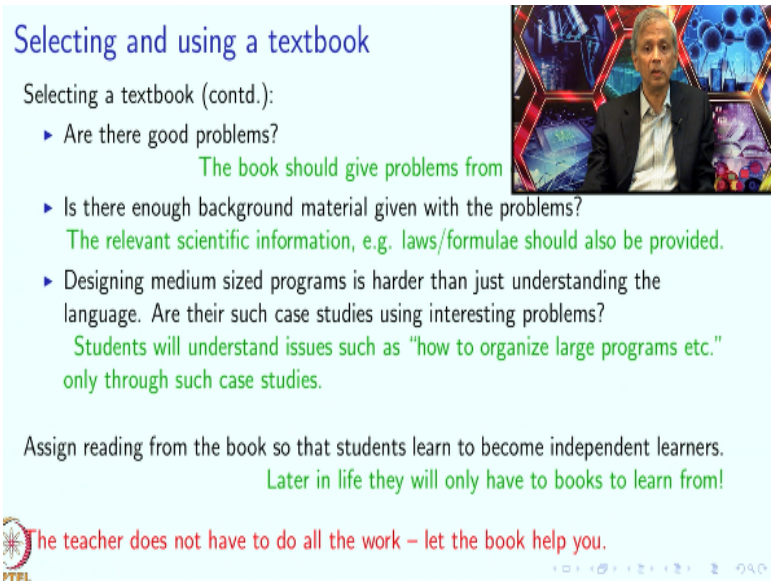

Okay so how do you select and use a textbook okay so also you have to check whether there are good problems okay. So, the problem is so the book should give problems from many areas maybe physics okay included it okay day to day life mathematics. If the book uses problems from physics if it is self-contained as we said earlier the book should perhaps point out that these are the relevant facts that are needed from physics okay. You could say that the book could leave it to the student.

But we are not going to be are not expecting to ask very deep problems in about physics than we talk of and we unite our students to write programs. So, the simple principle could be restated it would be lot of comfort for the student okay. So, the relevant scientific information should be given. Now introductory programming mostly will work with fairly on small programs and by that I mean maybe of the order of twenty lines. Because even mastering 20-line program is not easy.

Our first set of lecture said that 30% of the students fail and that is because they cannot even write 20 line programs. So, 20 line programs are most common but you know that industrial programs are million lines we do not need to go that far. But we could think about 100 line programs and towards the end of the course the student should be able to write some 100 line programs or at least conceive of some 100 line programs.

Now 100 line programs are qualitatively different from 20 line programs okay so 100 line programs I think will have to be written slightly differently. They have to be under names differently and so how to organize programs will be an important question that has to be discussed for this. Some case studies are probably the best idea and you should check does your textbook your selective textbook do such case studies okay and only through these case studies will your students understand issues such as how do I organize large programs.

If you use a textbook and we are saying that you should use a textbook you should assign the reading from the book so that students learn to become independent leaners. So, from time to time you should say look read this from the book because later in life they are only going to be learning from books so get them some practice ask them to read from the book and ask them to report to you look did you have problems. So, maybe I should be teaching you how to read a book as well.

The important point as far as you are concerned as far as teachers are concerned is that a textbook actually reduces our work. A good textbook is there for helping this so let it help you.

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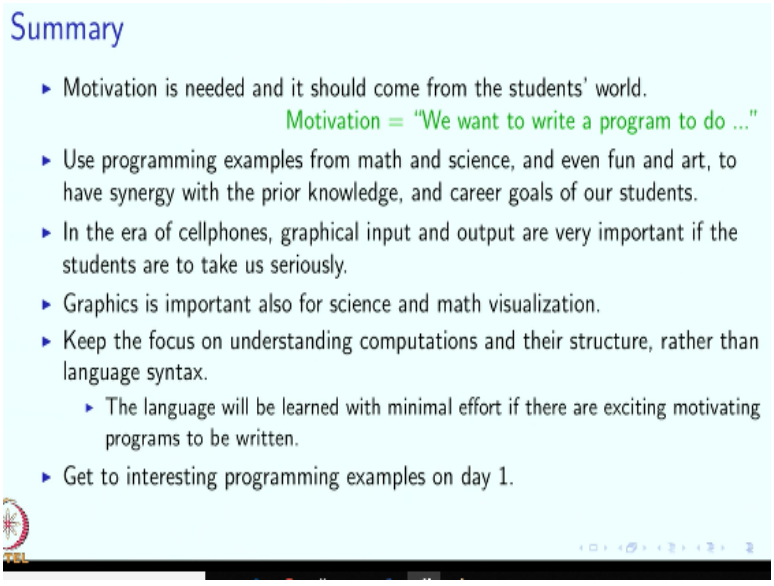

So, motivation is needed and it should come from the student's world. Motivation is why do we want to study this topic; why do we want to write thought that motivation will usually be of this kind. We want to study this topic because we want to write a program to do whatever whatever

whatever without which without the current topic that we are studying we would not be able to write that program. Okay you should use programming examples from math and science and even fun and art to have synergy with the prior knowledge and career goals of the students.

In an era of cellphones graphical input and graphical output are very important if the students are to take us seriously. And graphics is of course very important for science and math visualization. Finally, do not let the details overwhelm you keep the focus on understanding computations and structure rather than the language syntax. Okay so the language syntax will get learned okay if there are motivating programs to be written. So it is like fables called Panchatantra.

So, there are stories each story reminds you of a principle you remember the story because it is interesting it is fun but do remember the principle as well. So, if you make a story which will sort of a killer application as it is called sometimes for loops for a high loop what application do I think when I think of it I look. If you can somehow get the students to think in that manner they will understand and remember the syntax with very minimal effort okay and finally if you want to get to interesting programming examples on day 1.

To use the enormous energy that the students have in the beginning and last but not the least use a good textbook. Okay so we will take a break here and after that we will come to the scaffolding thank you.