Advanced Cognitive Processes
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Lecture - 26
Problem Solving – I

Hello and welcome to the sixth week of the course introduction to Advance Cognitive Processes. I am Ark Verma from IIT Kanpur, and we have been talking about various cognitive functions in this course till now. This week we will start talking about problem solving. Problem solving is one of the very complicated; it is one of the complicated you know cognitive activities that people do on a daily basis and in some sense lot of times you do not appreciate.

People do not really appreciate that what are the different mental processes what are the different cognitive processes that are contributing to somebody is successfully solving particular problem, and those problems can be very simple as to say for example, choosing between two colors or sometimes very difficult suppose for example, if you have to you know solve amaze with the given particular time or say for example, you have to you know solve the Rubik's cube where the time boundation.

Now, at this point in this course and I will try and link this to the earlier course that I have also taken introduction to advance to basic cognitive processes. We have by now talked about most of the basic most of the cognitive processes that kind of contribute and kind of you know help in building up approaches and help in building up strategies that people might use in problem solving.

We talked about attention, we have talked about perception, we have talked about memory, we have talked about biases, in this course even we talked about language, concepts, knowledge, categories. So, all of those things now you would need to invoke and understand how all of those component cognitive processes are contributing to people finally, achieving you know goal states from say for example, initial you know state where problem is stated.

So, I have already mentioned in the description now, that I have been talking I have already told you what you might expect from this week

So, we will talk about how people approach problems, what are the different strategies that people might invoke to solve particular problems, what are the obstacles in solving problems and what are the factors that might help what are the strategies you know that might help people solve problems.

So, the whole week will be about problem solving, and we will have short lecture on creativity as well. This creativity in the sense is also a very important aspect of solving problem. People were creative solve problems in you know in more efficient in genius ways as compared to ordinary people or as to supposed to people not rated highly creative, but again both of them achieve the same goal state, starting from an initial state.

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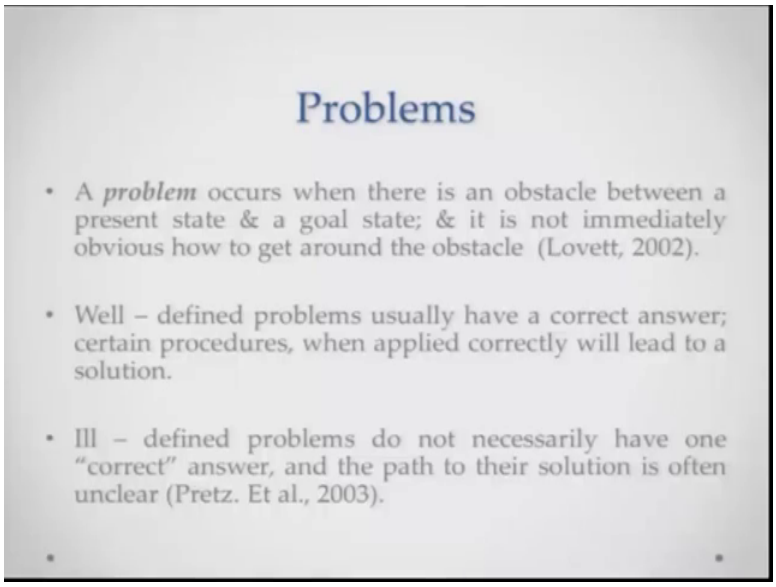

I have mentioning goal and initial state multiple times. So, I think this is the good time to already define what a problem is. So, a problem basically is when there is an obstacle that you have to overcome and surpass, in order to reach from initial given state to a goal state. So, the idea is you know somebody or in some sense.

You have given a particular statement of a problem and the statement of the problem might define an initial state. Suppose for example, you know somebody could give you an equation that solve for a x, x plus y is equal to 5 and x minus y is equal to 2 something like that, and then you basically you know have to figure this out.

Now again I just arbitrarily picked this up, but the idea is the statement of equation is the actual state and it is this is what they given knowledge is when you have to take particular steps to solve for the you know to variables. So, the idea is how are you going to do it, how are you basically you know going to tell us the values of x and y starting from two equations that are given.

So, and the obstacles that you have to do some calculations you have you know change around equations a little bit, co forms some competition then only then you will reach. Simply or say for example, if you take this to a different way, somebody could give you that there is a stuffing the cage in you have to go and make you know make tea for example, and come back with the tea.

The idea is you go there, you probably not really make tea active make tea earlier, but there are these you know components there the ingredients are there and then you have the kind of combine them in a particular fashion to come up with tea. So, there are steps that you will have to take, the initial state is where you have ingredients all separated at final state is that when you have a cup of tea.

So, how does one reach from this initial state to the goal state and what are the obstacles that you really need to surpass or overcome that is basically what is problem solving involves. Now there could be different kinds of problems that you would come across there would be problems which are very well stated which give you all of the information that is needed which indicate in some sense what might be the most probable most direct methods that you will take, most directs rules that you take to solve these problems, and these problems generally will have a correct answers.

If you spend enough time if you spend correct amount of effort you will eventually solve these problems if you are applying a particular kind of a method there are also these problems wherever are referred to is well defined problems.

The other kind of problems sometimes we come across in life or probably a lot of times is the ill defined problems. Now ill defined problems do not really necessary have a correct answer you know, what is good, what is bad you know is their god in the world those kind of statements are rather ill defined problem.

So, if you attempt to answer them with so much that is unsaid and there is so, much that is assumed or so much that you have to really you know work way. So, these kind of problems are referred can be referred to a ill defined problem, they do not really have a correct answer for that matter and the part today a solution that to really come up with a response is very difficult it is almost unclearance sometimes impossible to really come up with straight forward solution to such problems.

But you will see that people deal both kinds of problems on a daily basis, in the kind of you know work around in different ways to probable solution sometimes, correct solutions sometimes incorrect solutions. So, what we will try and do in this week is to see how people are actually achieving these goals.

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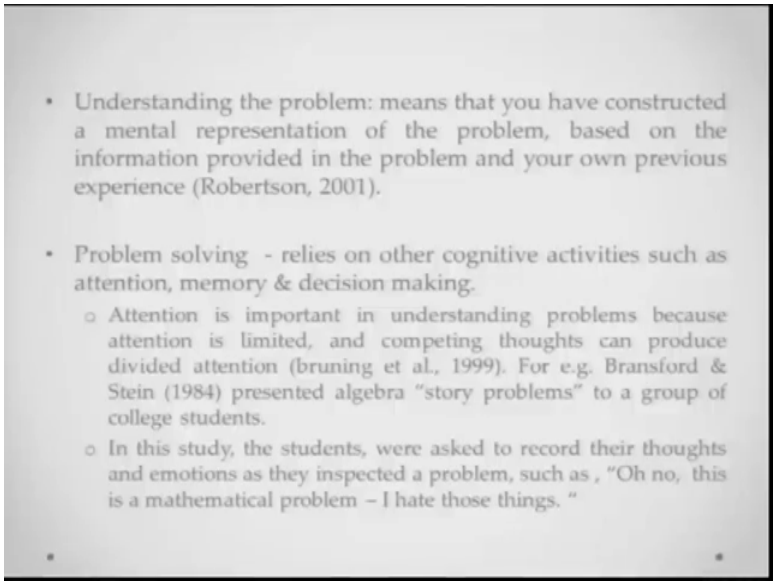

Now, one of the things is when you approaching a problem, what is the first thing would need to do? The first thing that you need to do generally is to try and understand the problem first.

So, the point is that you will not really be able to solve any problem, unless you understand what the problem is trying to say and a lot of time we tell students that even before you start attempting to answer a particular question writing your test or exams you should spend a good amount of time reading questions first; unless you understand what the question is actually asking you there is no way that you going to be able to give a correct or a effective answer. So, it is kind of you can take this analogy back to a

solving problems in real life if an all those different scenarios is that, we have to understand the problem at first. Now let me elaborate a little bit out understanding. So, understanding basically means, that you have already generated a mental representation of what the problem is, based on whatever is given in the problem and whatever your previous experiences have been. Suppose for example, somebody is giving you again let me go to the tea things.

So, the problem is to make tea, now the idea is you have been given ingredients that is the given information you have some tea and you have some tea leaves, you have some milk you have some water, you have some sugar and then your previous experience is the that you know that you know these things have to be cooked and they have to be mixed in a particular order to finally, make tea.

So, you have to first understand what really needs to be done with the problem. And understand basically means that you have that if created that kind of material representation. Now problem solving as I was already saying in the introduction is basically an activity it is a complex mental activity, that builds upon several other cognitive activity such things like attention perception memory reasoning, decision making all of those things kind of will contribute to how you are going to approach a particular problem.

So, let is let us take a few examples for example, attention is something very important. Attention or you kind of in more common parlance way you can call this as concentration. Attention of concentration is a is very important in somebody being able to understand a particular problem because attention is limited there are limited attentional resources and you have to allocate them wisely, you have to allocate them in a you know efficient manner.

So, that you kind of are attending the most relevant aspects of the problem that is stated and only then you will able to move forward from step zero to step one. Step zero is the initial say for example, first step you take towards a problem towards solving this particular problem and it has been shown that you know say for example, if you have competing thoughts, if you have particular kinds of distractions, your attention will be limited and you will not really be able to engage with the problem correctly.

One of the studies done by Bransford and Stein in 1984 demonstrates this very well, they presented high school students with story problems and they these story problems like algebra problems, and what happened was what was happening was that the students were asked to recall whatever they would thinking in their heads and they were supposed to write those things down while they attempted to solve the problems.

So, what happens is, that the students basically are having thoughts like you know oh no this is the mathematical problem, do not really like Math's, those kind of things they have to you know completely dropdown. Once they start attending to their thoughts, not really attending to the problem so, much and these thoughts kept coming on and on.

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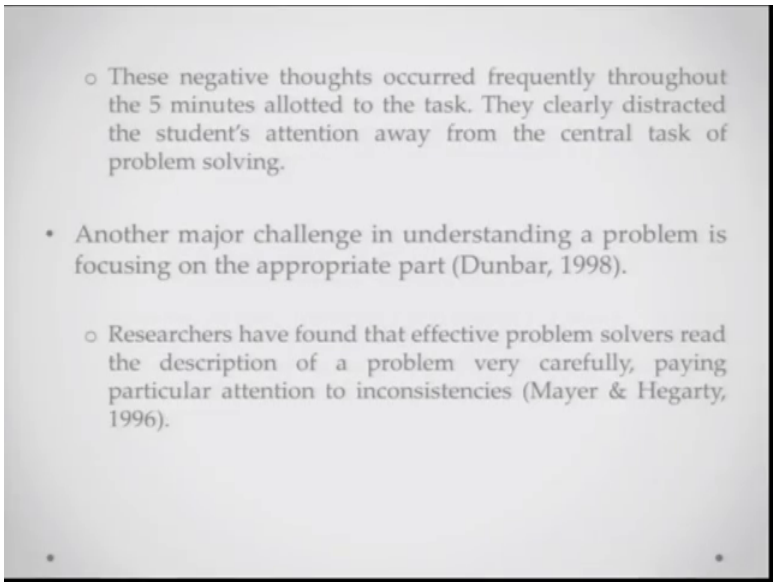

These negative feelings kept coming on and on throughout the five minutes that were allocated for solving problem, and these things particularly distracted the students attention from the central task. Now what happens is; obviously, eventually their solving of problems was less efficient, probably they made more errors, they committed you know they took more time.

So, is this is good demonstrational fact that if you distracted if not really concentrating, if your attention is not there on relevant aspects of the particular problem, you will not really be able to achieve the goal that is one. The second is again as a subset of attention; very important aspect of solving problem is focusing on the appropriate sections of the problem.

Focusing on the problem in such a way that you already get a clue from the problem about how to you know start approaching it, how do you start solving it. So, researchers have found that you know effective problem solvers people who are very good at solving problems, difficult problems, they read the description of the problem very carefully.

I was always hinting to how you know students should approach questions papers and stuff, as a research and there is a research Mayer and Hegarty in 1996 have shown that effective problem solvers do read the description of the problem very carefully. They spend and they allocate a good amount of time in reading whatever the problem is saying, paying attention to inconsistencies paying attention to patterns, and this attention might contribute in them solving the problem.

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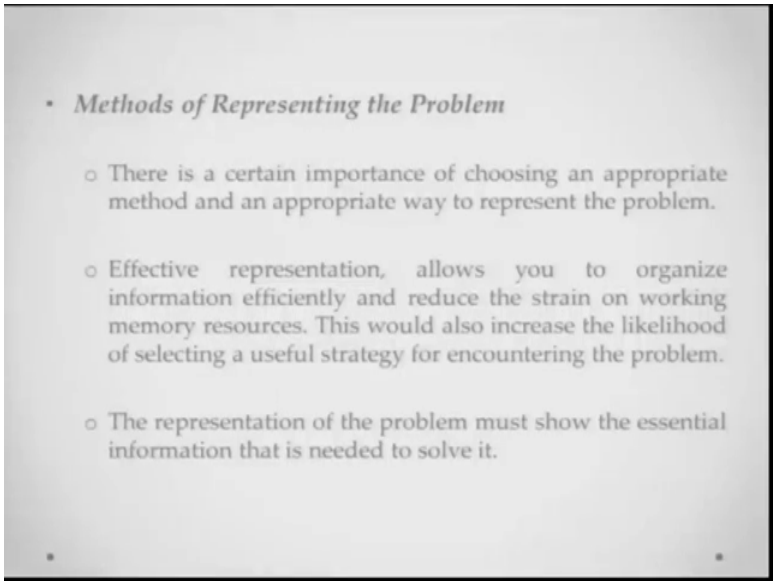

So, that is that is very very important. Now, let us move further one of the other aspects that I would like to talk to you about in general about problem solving is that the way the problem is stated, we have talked about the framing effect in an earlier lecture that how a particular problem worded kind of changes or impacts how people are going to react to it.

Now, the way something is represented the way the problem is presented to you or the way you represent the problem to yourself, might be reading a very difficult equation or you might be having a very difficult passage of a text in order to understand it, the way

you can change the way you can represent this thing to be yourself this problem to yourself determines and has a contributes a lot to your being able to solve problem.

So, there is this importance of choosing appropriate way to represent the problem there is, and that is basically effective representation allow you to organize the information rather efficiently and for example, it will reduce the strain on things like working memory. You know you will not really need to maintain everything through rehearsal in your working memory. If you have organized something very well, suppose if you drawn a picture or something all of that information is out there and you just have to kind a put the pieces together and solve the problem.

So, effective representation would increase likelihood of you being able to select a very useful and efficiency strategy for encountering the problem. Now moving ahead; the representation of the problem one of the important factors is that, it must show it must depict the essential clues essential information that is needed to solve a problem, that is what is an effective representation. Unless it does not unless it really gives you that relationship, it is very difficult for you to evolve and start approaching at the problem.

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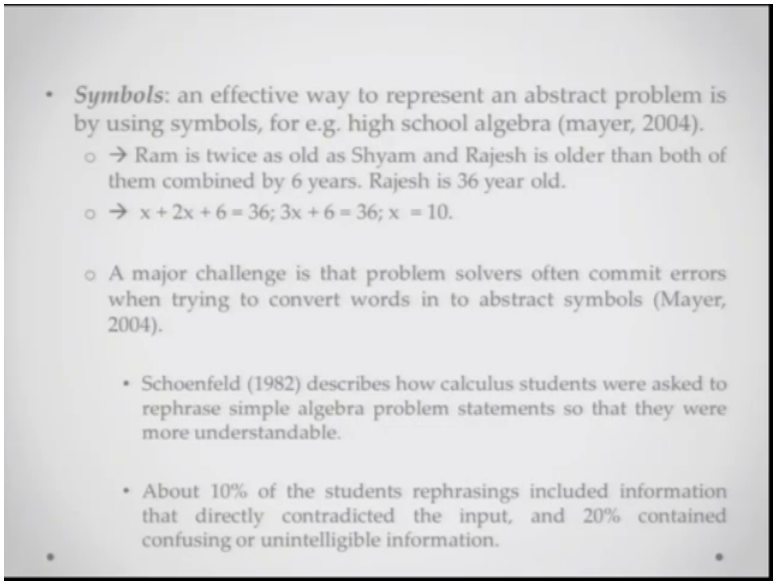

Let us talk about the few ways in which people represent problem. Suppose for example, in high school algebra, you would have basically sometimes be given word problems and word problems something like say for example Ram is twice as old as Shyam and Rajesh

is older than both of them combined by 6 years, and then you have been given Rajesh's age, Rajesh's age is 36 years old.

You can just kind of you know spend a minute over it, and come up with the equation which says x plus 2, x is plus 6 is equal to 36 and you immediately get to the in a couple of steps you already get that x is equals to 10. So, Ram is basically 10 years old, Ram is only 20 years old and combine both of them adds 6 is the Rajesh is Rajesh's age which is 36. Now the idea is in words a lot of times people would struggle figuring out and I will talk about, how people struggle with a statements in a bit, but the good way of doing it is just write an equation, you have all three ages and then it is very easy to perform mathematical computations and figure out the age.

So, this is one example that people might use different kinds of ways to represent problems, which will help them to solve. Now the major challenge here, a major challenge that problem solvers often commit is that the commit errors when trying to convert from words to abstract symbols you know. These kind of algebraic problems the word problems you know people solve in standards in third fourth fifth and sixth, the problem in really eventually solving.

It is basically there are lot of things people make errors in translating the word to the equations. So, Schoenfeld basically showed this and Schoenfeld showed this at 1982, he was describing how calculus students were when they were asked to rephrase simple algebraic problem statements, the and they were basically asked you just make it more understandable. It was observed that about 10 percent of the student's rephrasings how they were actually rephrasing the statement, included information that directly contradicted the input.

So, whatever was actually given in the problem statement, when these people rephrase those problems they kind of rephrase is done in such a way it kind of meant opposite to what the original problem was. And 20 percent of the rephrasings basically included really confusing or unintelligible information. So, idea is when they are converting the word problem into their own representations, they are kind of missing out an important information a, and in some sense kind of putting it together in such a way that it is almost impossible to solve it.

Now this is this is something very important the aspect of verbal intelligent the aspect of understanding language also comes in here you know and it kind of sequences, in that is why I was saying that you know problem solving process has a lot of components to it.

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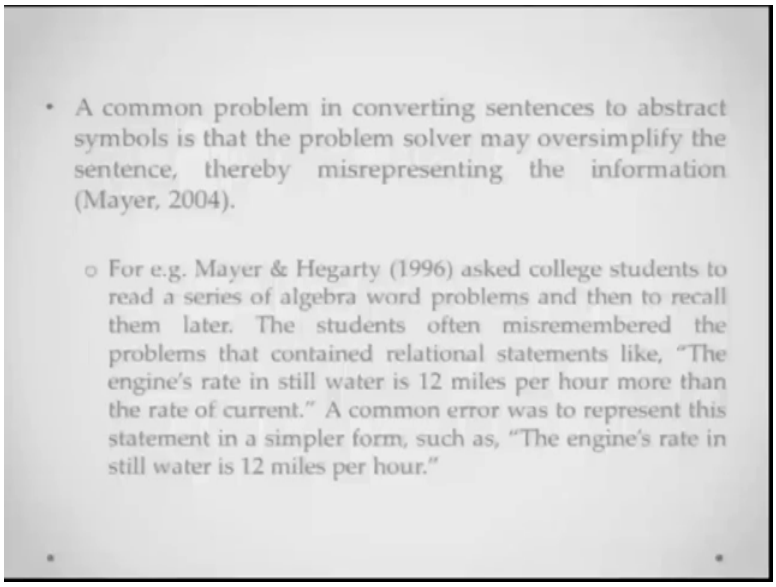

Now, another common problem just something that is links to what we are talking about is, in converting sentences to obstacles symbols is at the sometimes what the problem solver may do is, they might over simplify the sentence and in that oversimplification, the misrepresenting information. So, Mayer and Hegarty in 1996 they did this, and they were asking college students to read a series of algebra word problems and then you are asked to recall them later.

Now it was seen that a lot of times students misrepresented things like relational statements, which would have been very important to solve those problems. And example is suppose the statement is that you know the engines rate in still water is 12 miles per hour more than the rate of the current and a lot of students just remembered that you know the engines rate in still water is 12 miles per hour.

So, if you kind of miss out on the fact that is 12 hours and 12 miles per hour more than the rate of current, you will you are missing out of something very important that actually might have been used to solve this.

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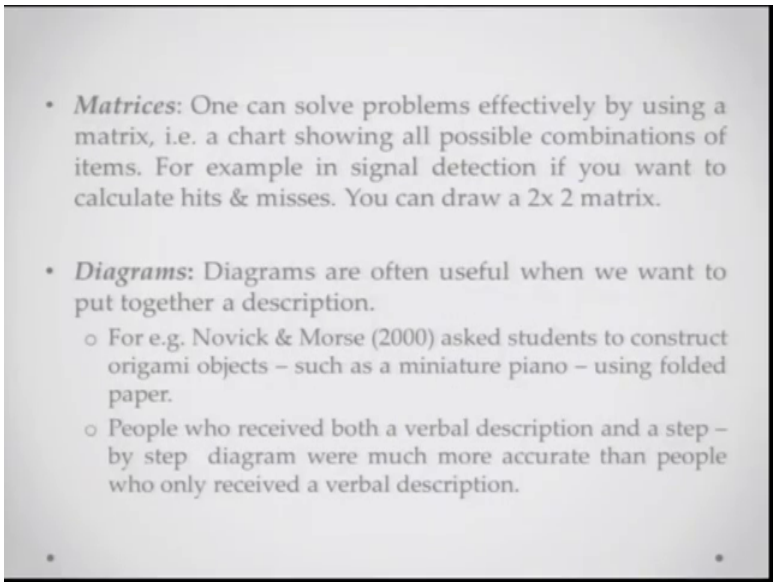

So, that is something you know that is just an example demonstration of how people might commit mistakes in changing or converting representations. Another way of representing problems might be using matrices. So, one can solve problems effectively by you know sometimes building just boxes matrices say for example, if you are reading signal detection, presents detecting, presence and absence of signals.

So, there is a high possibility that the signal is present there and you will detect it is the high possibility then signal is not present, then you will say no then the signal is not there, but there are also possibility to the signal is there and you do not detect it. Also possibility if signal is not there, but you say a false yes.

So, in signal detection usually how people do it, you can just draw two by two matrix and they said signal present yes no detected yes no and it is very easy if you can just fill in those boxes, you will get what is the percentage of hits, what is the percentage of misses and stuff like that. If there is a big text explaining that in this is the pattern of formation, just put that in the two by two matrix, and it will tell you what the pattern of performance of the participants are.

And that is a good way to understand a particular problem as well. So, matrices are very useful I mean sciences engineering various cases, matrices are very important to actually look at and they help understand and simplify the representation of problems to a great extent. Another way that it is a again a very common way of people representing the

problem is by virtue of diagrams. Now diagrams are very useful when you want to put together you 2000 they asked students to construct the origami objects suppose say for example, billing a paper crow or miniature piano something like that. And they were supposed to do it using folded papers.

People and there were two kinds of people who are doing these experiments one group basically received only a verbal description and the other group basically received a verbal description and a step by step diagram as to how this is done. So, for example, if you know if you sometimes what some electronical appliances, which need assembly or some kind of we used to have in school s u p w kind of things, were you have step by step demonstration of now fold this then this there then now fold this one and then the this is going to appear.

So, students who were actually receiving both the verbal description and a step by step diagram of how to go about it, were actually much more accurate and efficient than in people who just received to the verbal description.

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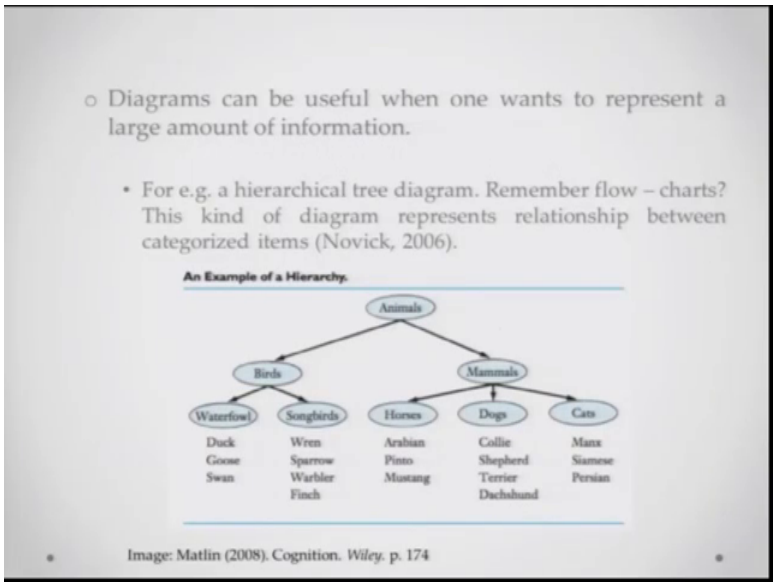

Also another very important thing interesting thing about diagram is, diagrams can be useful you know when somebody wants to represent large amount of information in just one second. Assuming example of matrices say for example, here if borrowed figure from Matlin's book on cognition, there you know things this is basically representation of the you know different categories of items. For example, you see animals and the

birds and there are two kinds of birds, whatever songbirds and the mammals is horses and dogs and cats things like that all of those things are organized in a particular way. So, using this diagram we can already understand what are the kind of you know hierarchy that is existing in these set of objects.

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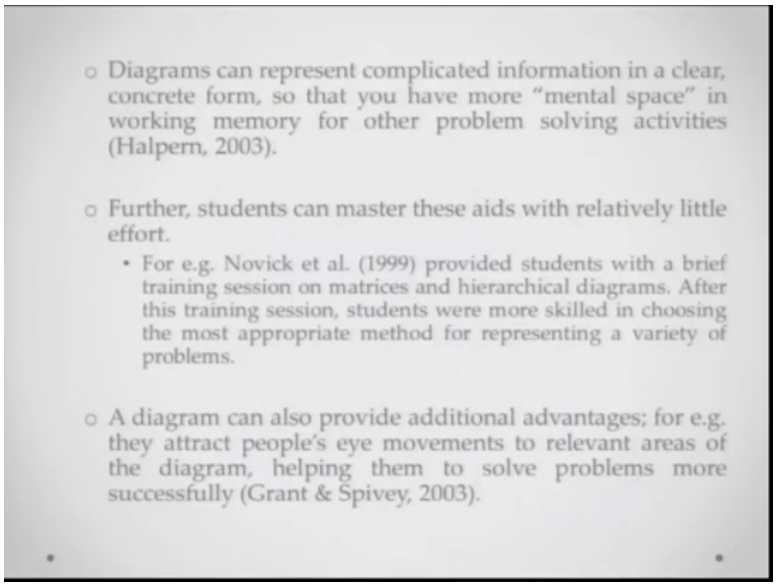

So, diagrams are also very efficient way of representing large information that can be understood and can be used to solve particular kinds of problems. Diagrams can all are also very helpful in representing complicated information in a clear and concrete form. So, that you have more mental space suppose for example, you are spending half of your effort in just or half of your working you are just maintaining that thing, if you just draw it out sometimes people do it when they are preparing or studying for exams, sometimes would just draw it out you know in a particular ways. So, that just you see the figure when you realize the entire concept.

So, these things are very important and they contribute a lot in peoples problem solving efforts. Also it has been shown is students can really master these aids, these different kinds of representation with relatively little effort. And Novick and colleagues they did this in 1999 and what they did was, they provided students with a brief training session on matrices and hierarchical diagrams. And after this training session they actually tested the students on different kinds of problems and they actually found, that the students who had attended this training session were much more skilled now in choosing the most

appropriate method for representing a variety of problems. So, already some training on this front and you know for students who are watching this can actually practice this little bit and this will help you in understanding complicated problems and you know; obviously, help you do much better in the studies part. So, this is again.

So, finally, I will just kind of trying some of the diagram thing, diagrams can also provide additional advantages for example, they would very simply just attract peoples eye movements you know. If there is a lot of things you see presentations if there is a very nice presentation with so many diagrams and figures, they would automatically attract our eye movements particularly attract attention to a relevant areas of the diagram, and in that sense a they are more memorize will and they are more easy to grasp.

You know and in that sense because that is easy to grasp, people will be able to use them and solve problems more efficiently. So, there is all about these things the diagrams, finely of the another things that is very important is figures visual images and it has been shown that people have been consistently using visual images to solve particular kinds of problems.

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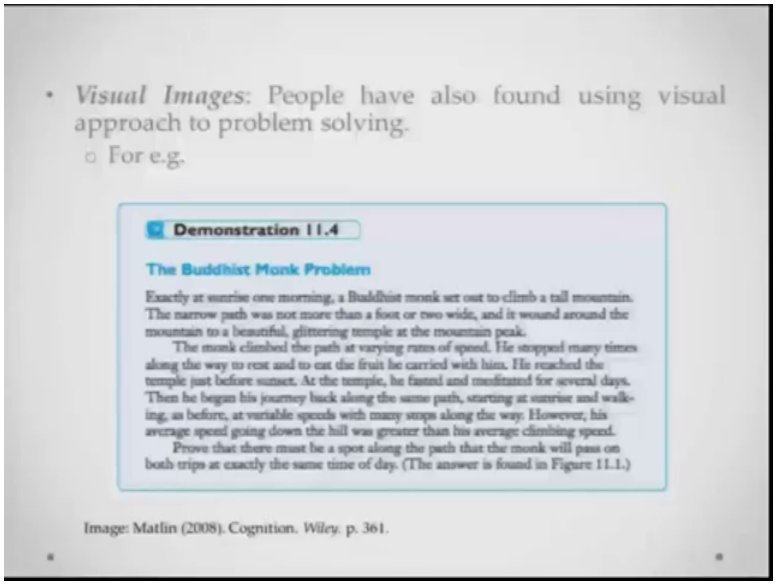

People have found that visual images are very helpful in solving problems. There is the demonstration you know from this book, is the Buddhist Monk problem and lets read this out to you little bit. So, the Buddhist Monk problem is very simplest very it is rather similar to the you know boat problem that we have in India, the boat has to cross the

rivers and there is a you know there is a boat and the crocodile it is this one is also very similar.

So, the Buddhist Monk problem is that you know exactly at sunrise on morning this Monk is set out to climb a tall mountain, then narrow path was not more than a foot or too wide it wound around the mountain to a beautiful glittering temple at the mountain peak. So, Monk quantity to read the temple and you know it early sunrise say the Monk starts approaching. The mountain Monk climbs the path at varying rates of speed he stopped at particular time.

So, it whatever food is got with himself, and he reaches the temple just before the sunset at the temple he fasted and meditated stayed there for several days and then he kind of began his journey along the same path again starting at sunrise and walking as earlier speeds and then he stops and now what the idea is the question here; is that you have to prove that they must be spot along the path coming back and going that the Monk will path a pass on both trips at exactly the same time of the day.

So, this is this is what the problem is, and you know you can kind of spend a minute or do pause this think how you will solve the problem, but if I have to kind of give you the solution or tell you an effective way of solving this is something like this.

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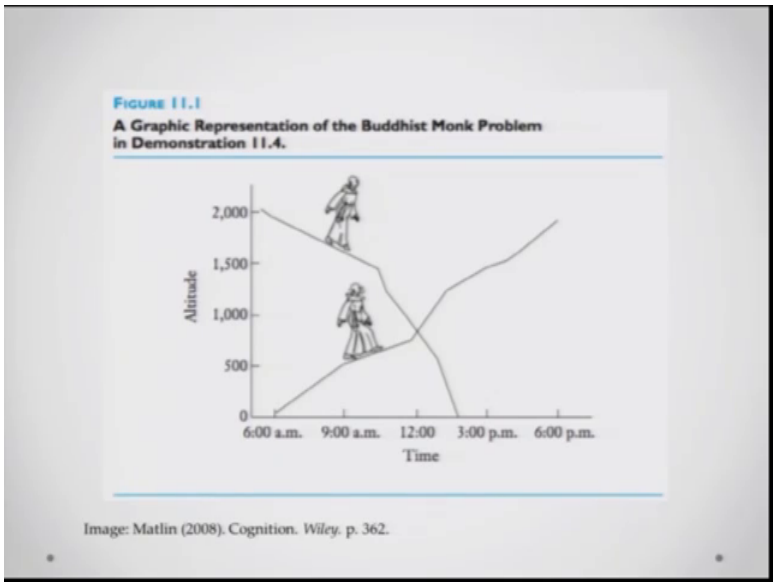

So, you know if you kind of assume that the start is almost happening at this same time, and a kind of varying the you know the factor in the various speed in sorts etcetera, they must be you know at around a half day part that the person is going to cross the same kind of thing, because you are assuming a lot of consistencies in this whole thing.

So, if you look at the figure, you are easily able to grasp the solution of the problem and this is just one example there are so, many other examples were a use of visual images is encouraged and visual images help you figure out problems much in the way as diagrams do.

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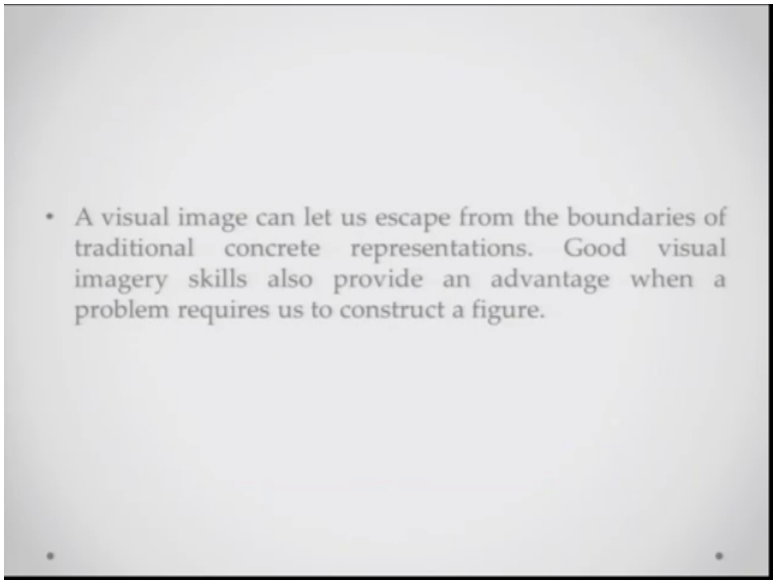

So, visual image can in assents help us escape from the boundaries of traditional concrete or verbal representations. And people who have good visual imagery skills also have an advantage that problem solving requires because if certain kinds of problem solving requires to make certain figures if you have a good mental imagery, you can actually use that to immediately draw a figure or immediately think of a visual scenario, where you will be able to solve that problem more effetely.

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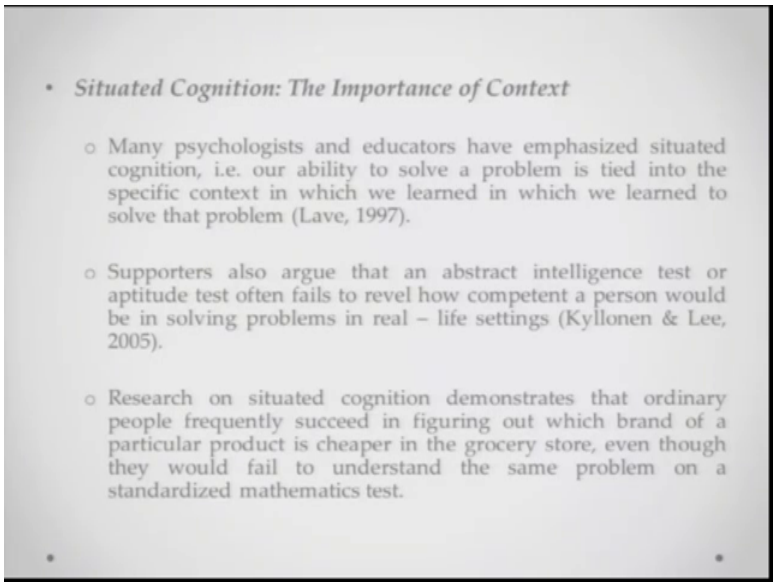

So, this is about the various ways of representing problems and you know what problems solving is essential, I will very quickly talk to you about a very interesting approach to a understanding how problems are solved, and this is basically about the importance of context where are you solving that problem, what is the scenario what is the setting, what is the place, what is the you know where is you know what kind of task you doing, and those kind of you know attention to these kind of details also contribute a lot in somebody being able to solve a problem let us talk about a this little bit.

So, many psychologies and educators have emphasized you know things like situated cognition you know. Situated cognition is our ability to solve a problem is that is in fact, type through this specific context in which you have learnt to solve their problems. Suppose for a example you have learnt to you know do any particular activity in a very specified set.

Suppose for example, you have learnt do a particular task let us say draw in a classroom or suppose a lot of things what happens is the students learn the in sciences and engineering students learn, how different kinds of engines, where called how different kinds of mechanics of materials work in their classes you know in their engineering classroom.

But a lot of kinds you see is they are not able to apply those things outside when they go inside the real world. You have to just take the concept from the classroom and take it

outside and try and apply it to solve the problem at hand and they are very ingenious thing suppose for example, I am remembering there was there was movie I think three idiots, and there in the person who is playing the main lead is using a lot of the things that he is learning in class in real life you know scenarios.

So, the idea is you can take whatever you are learning is inside the class outside as well. The fact is that a lot of time people are not able to do it, a lot of times our ability to perform particular task to achieve particular kinds of goals is tied to the context it is tied to where you have learnt this. And there are there are lot of example so, suppose it if argued that abstract intelligence test, often fails to reveal on how competent a person would be in solving the problem in real life setting.

So, for example, there is a student who does very well in the class, he does very well in all the assignments and tests etcetera, but as soon as you take the students out in a real life setting you know of things like you know civil engineering or architecture and those kinds of things, students kind of you know falter a bit and the hesitate and they there are problems of really converting this.

So, as compared to a particular students not really done very well in the class and assignments so much, but very quickly he can apply all of that what was learnt in a real life scenario. So, these kind of examples are there, and there has been a lot of research on situated cognition and that research demonstrations that ordinary people frequently succeeding figuring out, which brand of a particular product is you know cheaper in a grocery store, even though they would fail to understand same problem if it is asked mathematical test.

Certain kinds of decision making if you remember what we are talking about earlier in the lectures about the Culvani tribe you know. How people are actually solving (Refer Time: 29:43) for you know cart sorting problem four cart test, when they were given abstract thing they are there was problems in solving it, but when they were given a real life scenario immigration thing or bear drinking problem, they could actually solve it much more easily.

So, those are things you can actually link to the descriptions going on here. Now the traditional cognitive approach to thinking emphasizes the fact that you know processes that take place in side and individual persons head, while the while the situated cognition

of approach argues that the later approach to simplistic. So, the cognitive approach would basically say that everything is just happening in the persons head.

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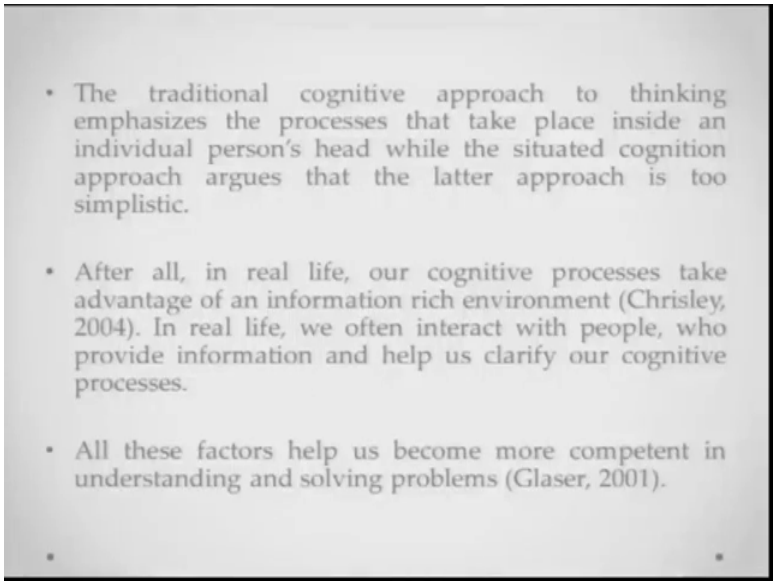

And you know the situation the external scenario does not really matter. But the situated cognition approach or a slash embody cognition approach in some sense says that, it is external environment also that contributes to somebody being able to perform a particular task. Now after all say for example, in real life or cognitive processes take advantages of the rich environment.

If you remember when you talking about the perception there is a lot of queues to solving inconsistencies of degraded inputs that you take from the context that you take from the environment. So, in real life we often interact with people who provide information and help us clarify our cognitive process you know, they help us map the abstract world to the real world and that is what helps us achieve good solutions to problem sometimes. All of these factors you know help us become more competent in understanding and solving different kinds of problems.

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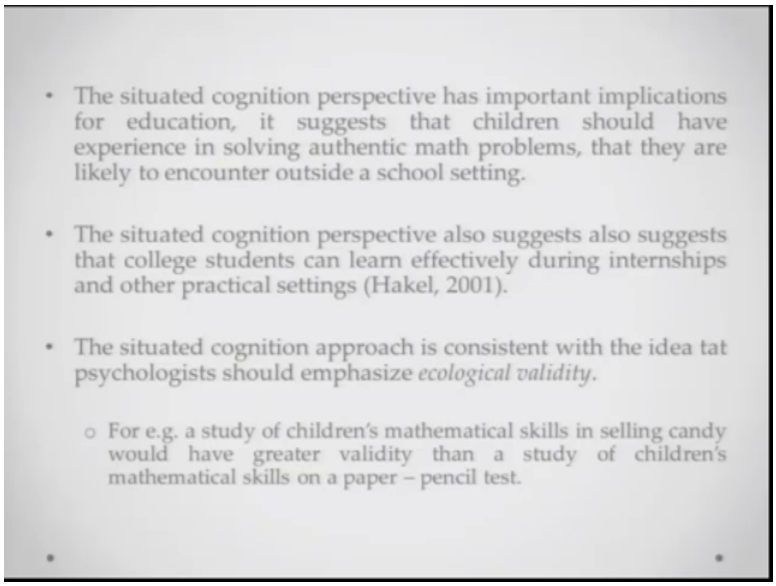

So, the situation cognitive cognition perspective has really important implications for education. It suggests that children should have experience in solving authentic math problems that they are likely to encounter in school setting. So, whatever they are you know really learning in school using abstract things, they should be actually also thought to solve real life problem with the real examples and they should be given assignments that help them to apply these abstracts principles that they learn in real life scenarios.

The situation cognitive perspective also suggests that college students can learn effectively during internships and other practical settings much more. Now a days they this lot of emphasis on applied education in. So, that is a that is a very good approach because it kind of tests how much you are going to be able to apply whatever you are learning in class to real life scenarios. So, that is why internships are a very good idea in that sense. Another situation in one of the advantages one of the things with situated cognition approach is that, these kind of approach is lend us more ecological validity. Know ecological validity is how much you can generalize a particular scenario to other different settings

So, study of students mathematical skills in a selling candy would have had greater validity than the study of you know am just doing some basic algebra. So, if you kind of tell that you know you have 4 candies and I take two away from you then the answer will

be probably faster and am talking about younger kids than if you just ask them 4 minus 2 is what?

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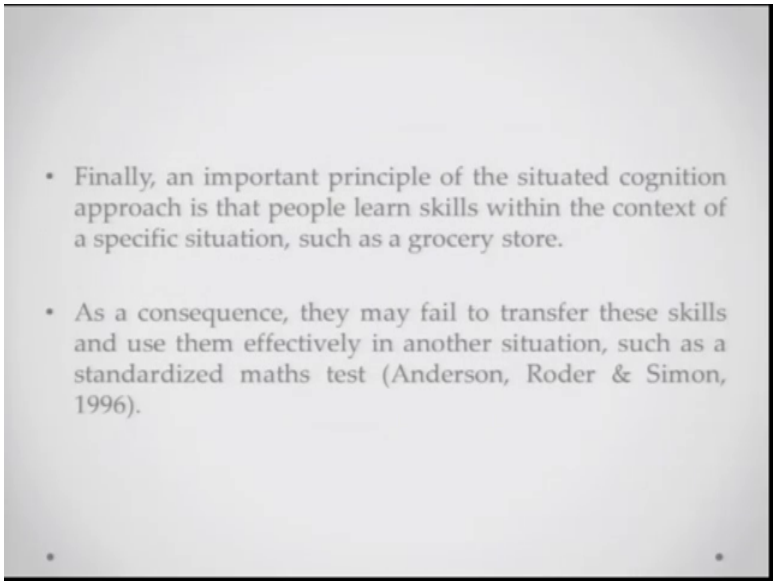

So, these kind of approach is this basically what the situated cognition principle kind of emphasizes. Now finally, an important principle of the situated cognition approach is that, people learn skills within the context of specific situations. Suppose for example, a grocery store where the kid is selling candy or stuff. As a consequence there is a good possibility that remains failed to transfer these skills and use them effectively in other situations such as a standardized math's test or something like that.

So obviously, for educators and employers etcetera good strategy could be to devise as a certain scenarios, where things are tested in such a way that there is opportunity to apply whatever has been learned in the abstract form in real life settings and then also the evaluation should not only be on the abstract is, it should always to be on the practical application aspects of it.

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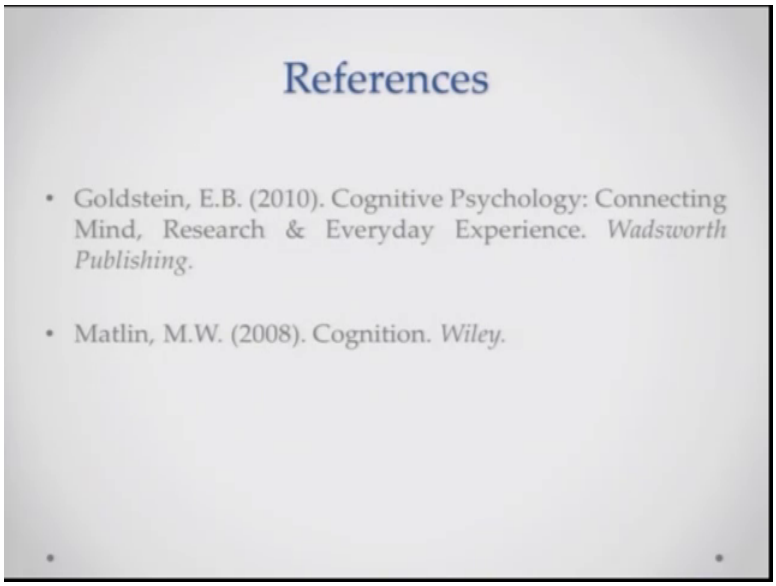

So that is I think, all from my side about a situated cognition and a basic introduction of what problem solving will be about; we will move to the next lecture and talk about more aspects of problem solving.

Thank you.