Advanced Cognitive Processes
Dr. Ark Verma
Department of Humanities and Social Sciences
Indian Institute of Technology, Kanpur

Lecture-28
Problem Solving – III

Hello and welcome to Introduction to Cognitive Processes, I am Ark Verma and in this week of the course, we are talking about Problem Solving. So, in the last lecture I talked to you a little bit about particular strategies of solving problems, heuristics and algorithms in today's lecture we will move slightly further and, look up at some traditional approaches to problems when you talk about research from the gestalt approach and will talk about research from the information processing approach now the gestalt approach.

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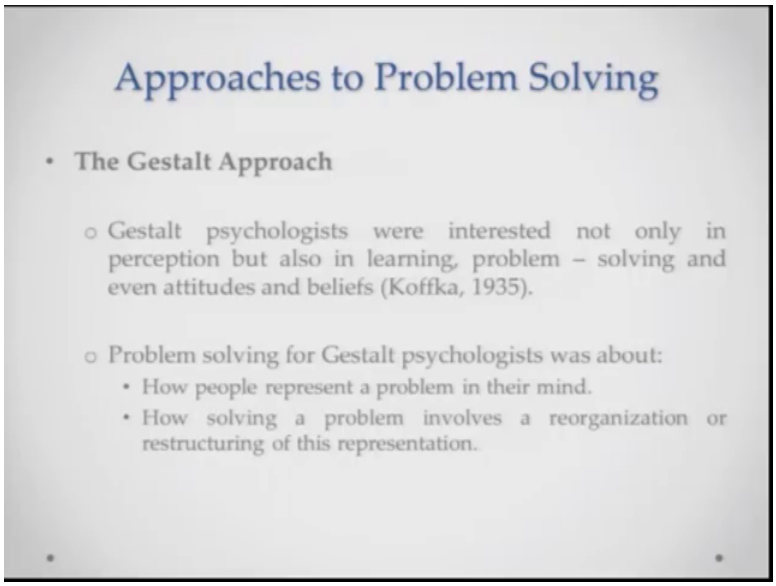

If you remember in history of psychology, if you have taken a course in psychology earlier the gestalt psychologists like Wolfgang Kohler Koffka and those kind of people, they basically believed in a particular theory and the theory could be just summed up in one of the things, in one of the statements and the statement was like the whole is more than the sum of it is parts. So, the idea is you have to look at the holistic picture and, the holistic picture gives you much more information things put together give you much more information, then they are tiny bits you know independently or separately. Now the

gestalt psychologists were not only interested in perception, but they also did a lot of work in areas like learning and memory in problem solving, they also were interested in working about attitudes and beliefs and so, on and so forth.

So, today we will just talk a little bit about their contribution towards problem solving research. Now the gestalt approach to problem solving, basically emphasizes on two things, it emphasizes on the fact that how are you representing the problem in your head, if you have to begin solving a problem, you have to figure out a way of representing the problem in your head correctly, remember we have talked about this a little bit in the first lecture on problem solving and, today we will just try and do some more demonstrations that is basically going to you know help you see the importance of representations.

Also the gestalt psychologists believe that solving a problem would involve a degree of reorganization, or restructuring this representation, it is not like that you can build a very inflexible and immovable representation of a problem and you are going to solve it 100 percent time. A lot of times you will be required to change your representation, you will be required to repre restructure your representation, in order to be able to solve the problem you know it is it is more like you have to look at the problem from different character and you know from different angles, or you have to know you know shuffle the problem around put it in such a way that makes it easier for you to solve the problem. So, these are the two major aspects that kind of in some sense summarize or highlight the gestalt approach to solving problems, let us see how it really works.

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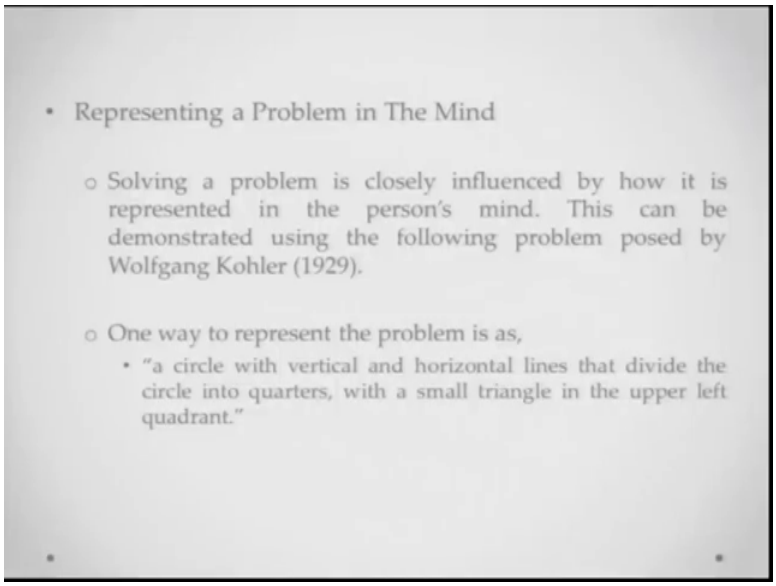

So, the first thing is representing the problem in mind. Now solving a problem the gestalt psychologists believed that solving a problem is very closely influenced, by how it is represented in the persons mind, how you are looking at the problem well you know almost there define in some sense, how you are going to solve that particular problem. And we can just demonstrate this by a very simple example and, this example was a problem posed by Wolfgang Kohler back in 1929.

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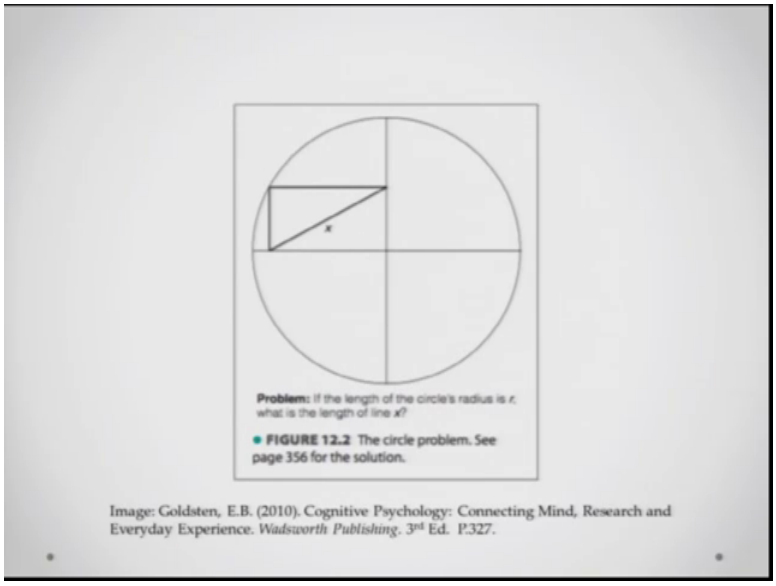

Now, this is the problem and you can look at this figure the figure is borrowed from Goldstein's book, but you can look at this circle here, you are seeing that there is you know triangle there the line the diagonal of the triangle is called the hypotenuse of the triangle is called x. And then what has been asked is if the length of the circles radius is r what is the length of the line x, what do you have to tell is you have to tell the you know length of line x and you have to compute it.

So, one of the ways to represent this problem is that a circle with the vertical and horizontal lines, that divide the circle into four quadrants, with a small triangle in the upper left quadrant. So, with a small triangle in the upper left quad this is how you can verbally describe it. Now is this definition is this statement of the problem going to be very helpful for you to solve this problem, you can just use this problem slide, you can go back to this statement and, let us try and figure out whether it is helpful whether you can you know solve this problem in such a way, after you spend a couple of minutes, after you spend a couple of minutes dealing with the problem in such a way.

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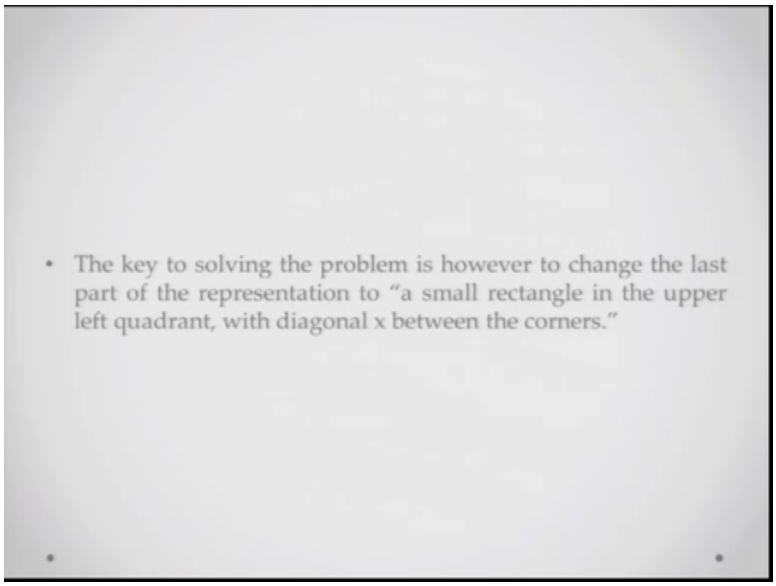

What you can also do is you can change the last aspect of the problem and, instead of a triangle you could just say that a small rectangle in the upper left quadrant is there and, the diagonal of the triangle is x, which is running between the two corners look at this triangle as basically a rectangle that is having the quadrant as two sides the boundaries of the coordinate has two sides.

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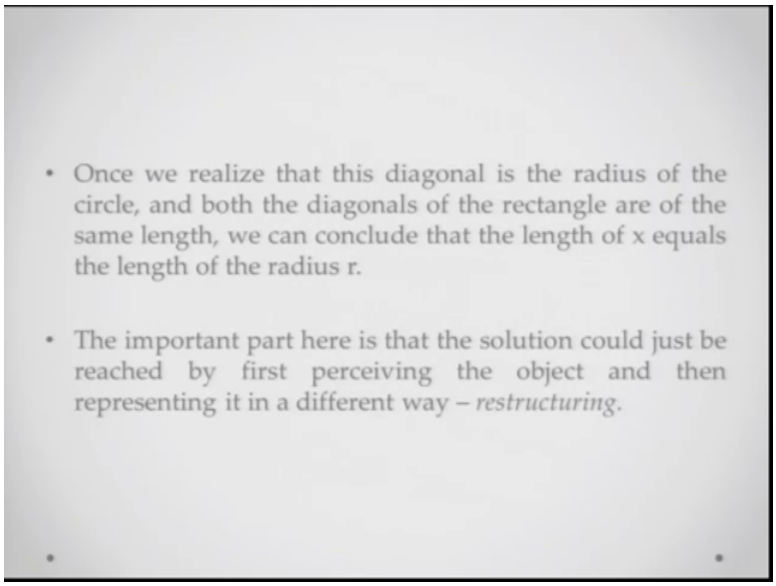

So, once you realize that this diagonal is actually the radius of the circle and, that both diagonals of the you know trying of the rectangle are of same length, you can very easily conclude that the length of x is actually going to be equal to the length of r. So, very easy to solve this particular problem, just by restructuring the way you were looking at the problem. So, the important aspect here is the solution could just be arrived at very quickly, by first perceiving the object completely and, then representing it in a slightly different way, this is what is referred to as restructuring. So, we talked about the representation part and this is how the restructuring of that representation would lead you to effective and a quick solution.

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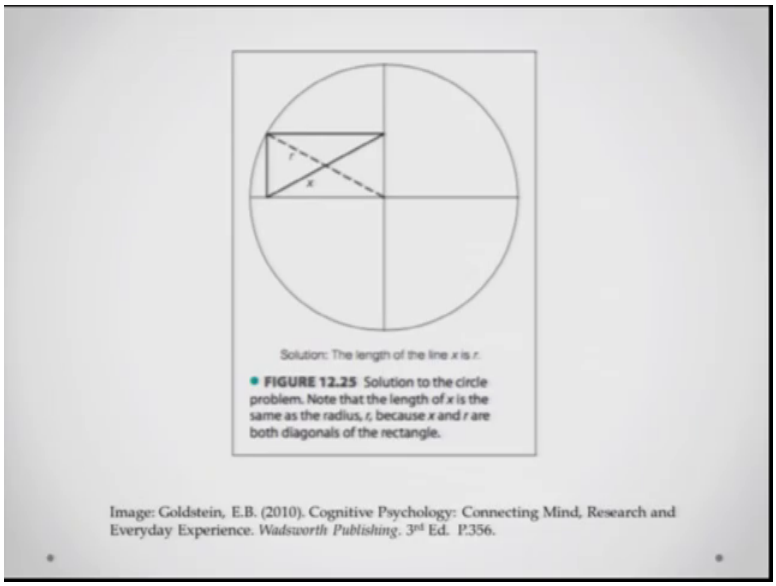

So, this is the solution, if you wanted graphic aid this is how you look at it and you see that r and x are exactly equal to each other.

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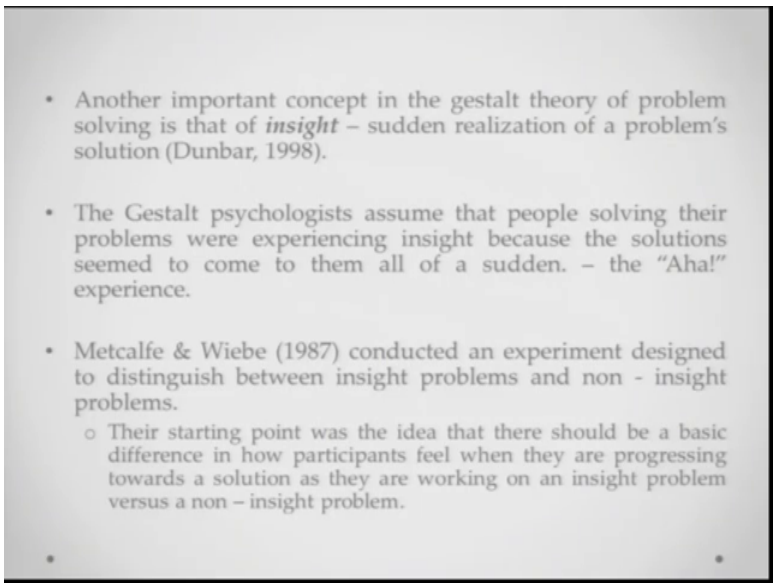

Another important concept in the gestalt theory of solving problems in this aspect of insight, now the gestalts believed that sudden realization of a problem, you know there are a lot of times people have a sudden realization of a problems solution, they assume that people solving you know particular problems, were sometimes experiencing insight, because the solution seems to come to them all for sudden.

So, they will be thinking and suddenly all of a sudden they, will just say that now the solution is there. So, there is no gradation you know there is no we are talking about the initial state and the goal state in the last lecture, there is no progression from an initial to the goal state here, if suddenly that you are at the initial stage and one minute passes and you are at the goal state, without this proper methodological planning.

This is also referred this has also been referred to as the moment, or the experience that suddenly you get a solution of a particular problem. Now Metcalfe and Wiebe basically, they did this research they wanted to differentiate between insight problems where, the solution will come up you know almost instantly and there is no proper method towards the thing and a non insight problem. And their basic assumption their starting point of their experiment was that there should be a basic difference in how participants feel, when they are working on an insight problem versus when they are working on an non insight problem.

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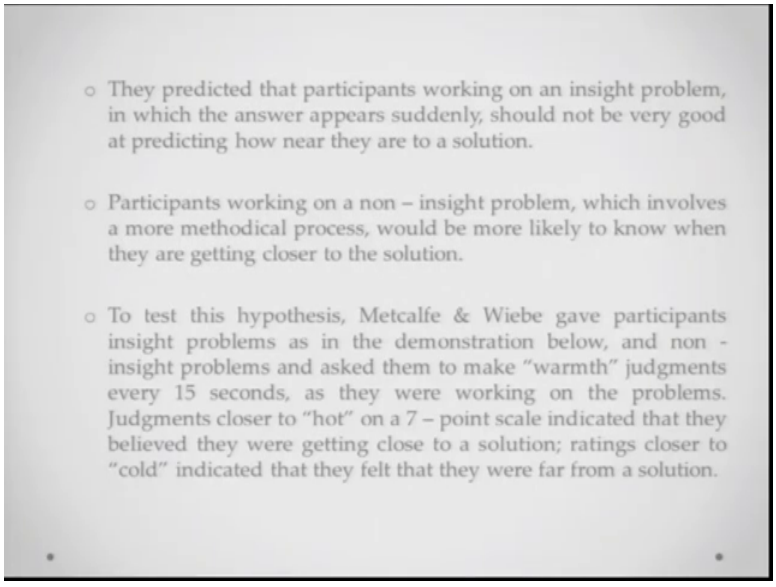

So, what they did was they predicted that participants working on an insight problem, in which the answer is supposed to appear suddenly, should not really be very good at predicting how near to a solution they are. On the other hand participants working on an non insight problem which involves a more methodological process, a methodical process would be more likely to know that whenever you know to know how far or how

closer to the final solution they are. So, this is what the two kinds of groups are and this is what they are you know assumption is.

So, they tested this hypothesis they wanted to test this hypothesis by giving participants insight problems, I will just show you the examples and non insight problems. And while these people were working on these insight problems, they were asked to make warmth judgments. So, warmth judgment is like the closer you are to a solution the higher your warmth rating will be. So, if you are very close to a solution, your you know your warmth rating on a 1 to 7 scale could be 6 or 7 even when you are far from the solution your warmth reading would be somewhere between 1 2 and 3 and something like that. So, while they were working on solution and, they were supposed to you know give this judgment of warmth every 15 seconds and, this is what they what the task was now.

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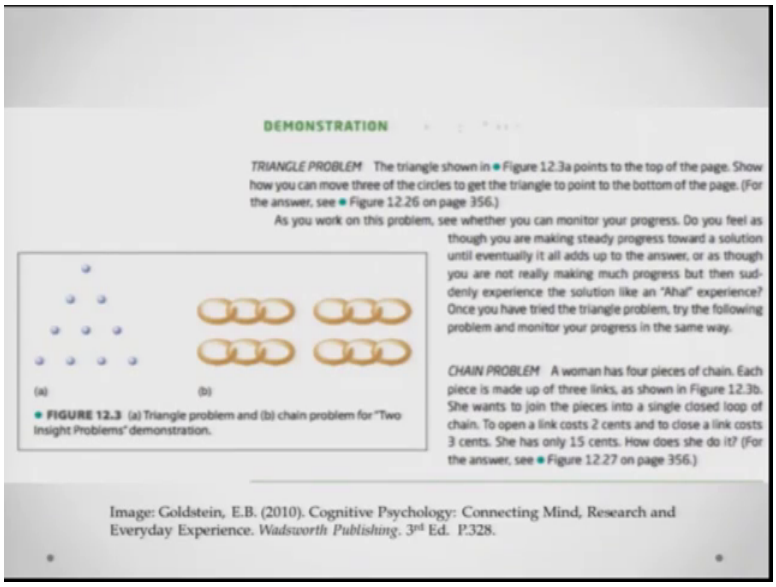

Image: Goldstein, E.B. (2010). Cognitive Psychology: Connecting Mind, Research and Everyday Experience. *Wadsworth Publishing*. 3rd Ed. P.328.

Let us go to the problems 2 of the insight problems are presented here, you can look at these figures again borrowed from Goldstein's book, you can see there is in the figure a there is a triangle problem and, the triangle problem basically says that in the fewest steps possible so, the idea is basically that show how you can you know move the three of the circles to get the triangle to point to the bottom of the page, you can look at the triangle is pointing towards the top of the page, you just have the choice of moving 3 of the triangle 3 of the circles that constitute the triangle and you move these three circles in such a way that the triangle starts pointing to the bottom.

That is one the other problem is the chain problem. So, there is a woman who has four pieces of chains each chain, has 3 you know links and the thing is that she wants to join these pieces, in a single you know chain in a single closed loop of chain. Now what the problem here is that to open a link is going to cost 2 cents, and to close a link is going to cost 3 cents. She has only 15 cents and how is she supposed to achieve this in just 15 cents.

Now, these are the two insight problems you have to kind of think over them think, or than think over there and it is highly probable that suddenly you will just get the solution in one set, there is no step by step hierarchical approach to solving these problems, you can kind of pause this and you know attempt to solve these things.

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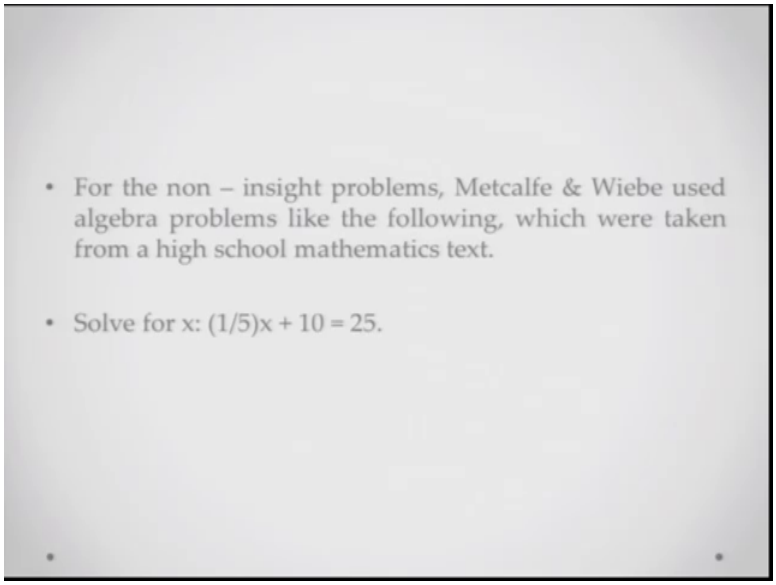

For the non insight problems they just picked up high school algebra problems. So, problems like say 1 by 5 of x plus 10 is equal to 25 and you have to solve for x again very straight forward, but there are steps in there you know you can move from 1 step to the next step to the next step and 2 or 3 or 4 steps would actually lead you to the final solution.

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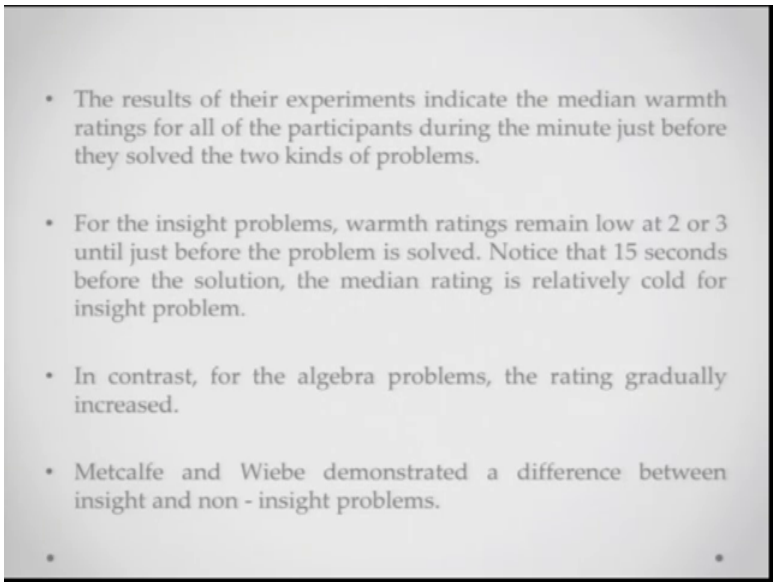

So, the results of their experiments indicated that the median warmth rating for all of the participants during the just you know during the minute, just before the solution is there. So, they kind of showed this and, for the insight problems it was observed that the warmth ratings remain at a very low 2 or 3, until just before the problem is solved. Notice that I will show you the results very quickly notice that just 15 seconds below the solution the median rating is very cold it is a relatively cold it is around 2 or 3, in contrast for the in contrast for the algebra problems the rating is increasing gradually.

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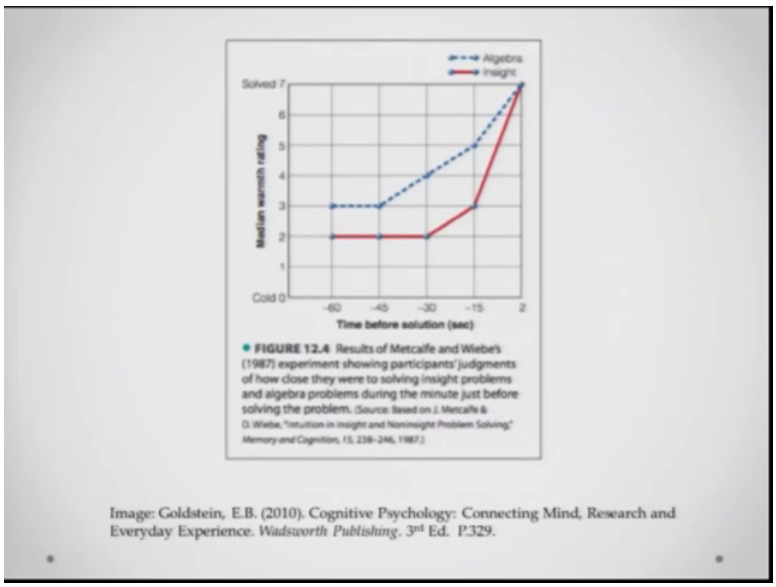

So, this is these are the results you can just see here, the red line is the insight problem and the dotted line is the algebraic problem, you can see here, that the you know the change from minus 15 to when the solution is achieved is a rather steep in case of the inside problem, but it is a relatively gradual relatively step by step in case of algebraic problems.

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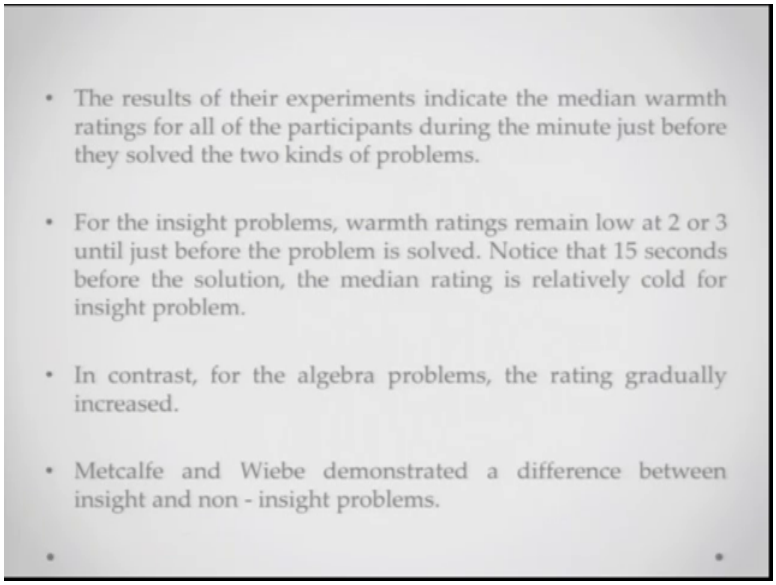

So, this demonstration basically you know it tells us something about the difference between what in how insight versus non insight problems are achieved are solved.

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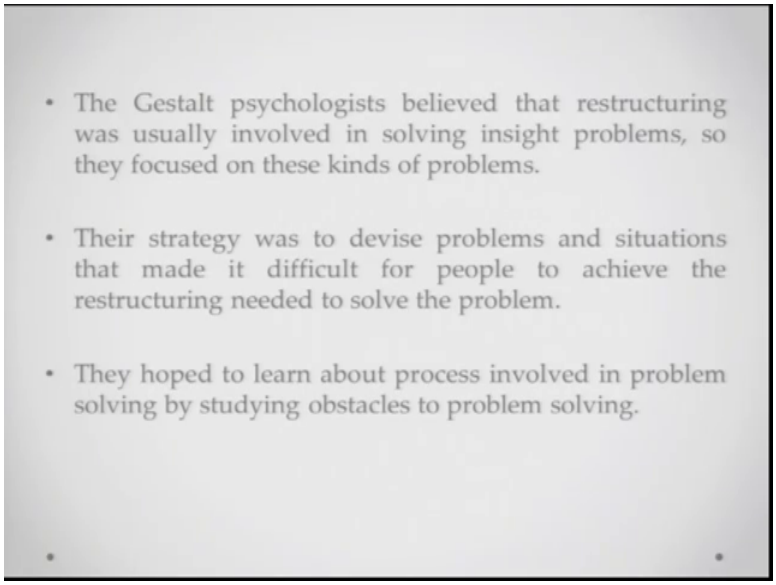

Moving on the gestalt psychologists believed that restructuring was usually involved in solving insight problem. So, they said that if you have to you know solve an insight problem, you have to do a lot of shuffling of their representation, you have to do a lot of restructuring. So, they kind of started to focus on devising these kind of problems their strategy was to devise a such kind of problems and situations and make it difficult for people to achieve the restructuring that is needed.

So, that they are kind of it is not methodologically possible to do it and, they are kind of only insight solvable problems. And they hope to investigate how people are solving these problems and by investigating that, they hope to learn about the processes that are involved in problem solving, and by the kind of obstacles that you know come when people are trying to solve problems.

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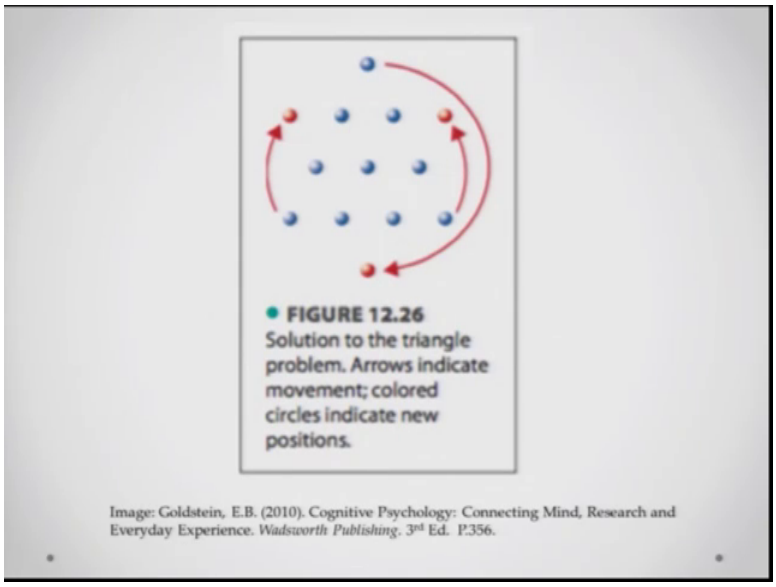

So, here again there is a solution to the triangle problem, you can see that this 2 3 dots three circles have been moved and, you can already see that there is a triangle starts pointing to the bottom of the page.

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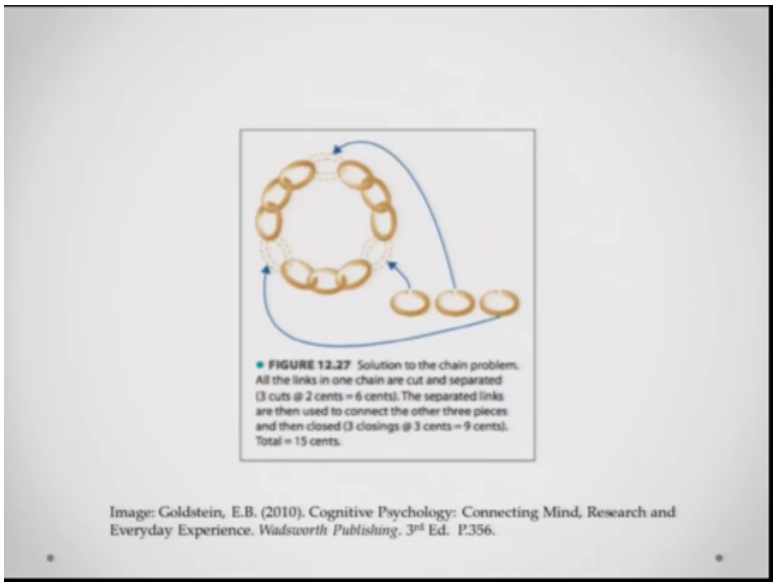

This is one of the solutions the other solution is here, again you just have to use 15 cents and, you can just need to open three links and close three links to basically be able to achieve this. So, 3 3 is 9 in the closing part is 3 2s a 6 and 9 plus 6 is 15. So, you are kind of doing it in just 15 moves 15 cents.

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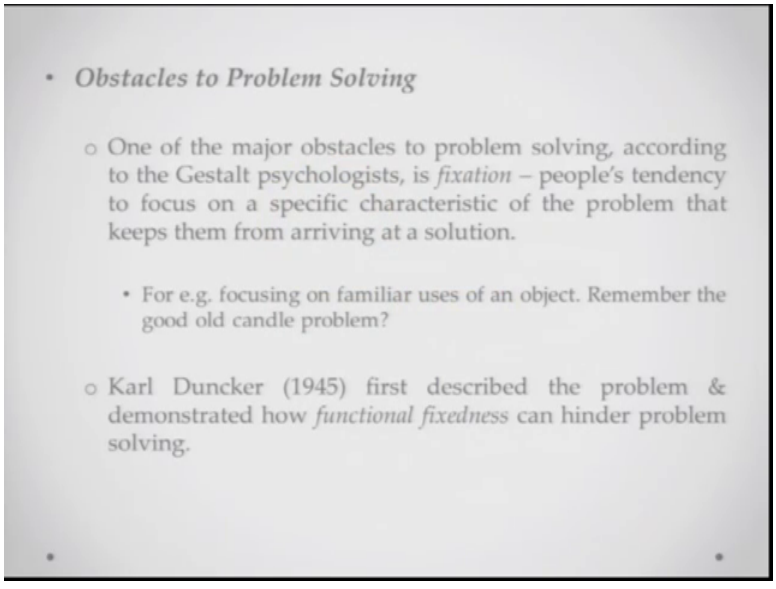

So, this is the kind of obstacles I was talking about. So, the kind of obstacles that you know come up that kind of are present, when people are solving problems are and, then there is a variety of obstacles that are there, but one of the very common obstacle one of

the very common problems you will see in people, who are very you know they are not very good at solving problems is that of a fixation and fixation basically is somebodys tendency is peoples tendency to focus on a specific characteristic of the problem that keeps them from arriving at.

Suppose for example, you are basically just fixed at one kind of way, or one method of solving a particular problem, you are not very open you are not really willing to restructure the probably not we really willing to think in more innovative ways and, then it is highly probable that you will be stuck with the same problem for a long time ok. On the contrary, if you are reflexible if you are open to looking at the problem from different perspectives, you might be able to reach the solution in a much more faster way. So, and a demonstration is due so the if you remember the very old candle problem. So, this candle problem was first proposed by Karl Duncker in 1945 and the candle problem serves as a demonstration of how functional fixedness, or how fix in a fixation to a particular way of doing things can hamper somebody's problem solving abilities.

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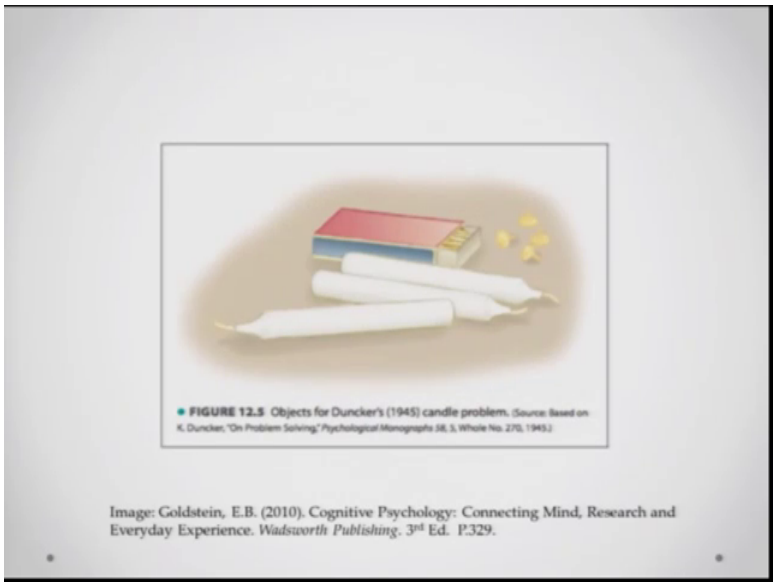

Just to give you a cue, if you remember, there is a candle, there is a matchbox and, there are these pins tacks, as you may call it. And the problem is basically to be able to you know fix the candle to the wall in such a way that no wax falls on the ground. So, this is basically the problem statement and these are the three kinds of materials that are given.

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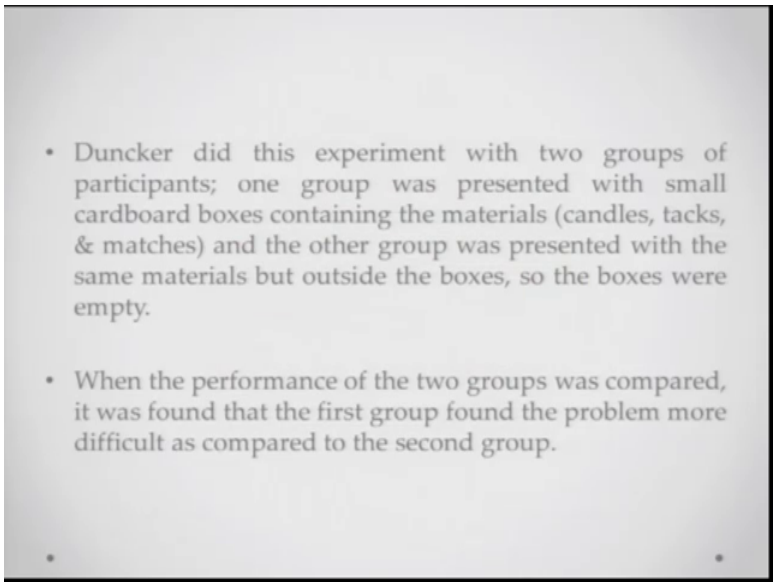

So, what dunker did was they he did this experiment with two groups of people two groups of participants, one group was presented with a small cardboard box containing the materials candle stacks and matches and the other group was presented with the same materials, but outside the boxes everything was outside and the boxes were empty. So, what they found was when they compared the performance of the two groups, they found that the first group found solving this problem in a much more difficult than the second group.

Now how is it happening what is the problem here, why is first row finding it more difficult. If you just look back at this thing and I am sure a lot of you would have come across this problem and a lot of you know the solution already, the idea is that you just attach the empty part of the box to the wall using the text and, this keep the candle in the match box. So, that whenever even when the wax is melting, it just falls within the box that is pretty much what the solution of the problem is, but the first group are basically not being able to see this extra use of the match box, they are just thinking that match box is used to contain and matchbox cannot be you know stuck to the wall.

So, this functional fixedness this fixation with using the box in only one particular way, is actually hampering their approach to solving this problem.

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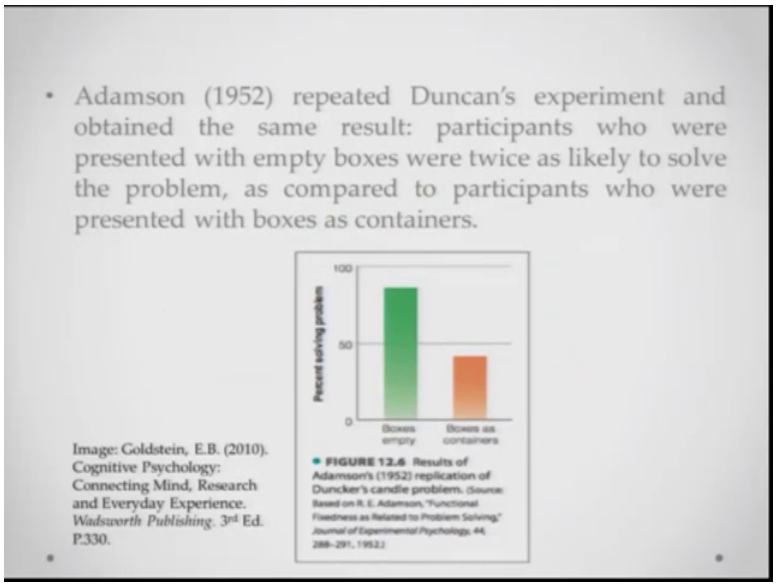

Adamson in 1952 repeated the same repeated Duncan's experiment and you also got the same result, participants who were presented with empty boxes, were twice as likely to solve the problem as compared to participants, were presented with boxes as containers because, boxes as containers is kind of priming and you know reaffirming the fact that boxes can only be used as containers and, cannot be used to attach to the wall.

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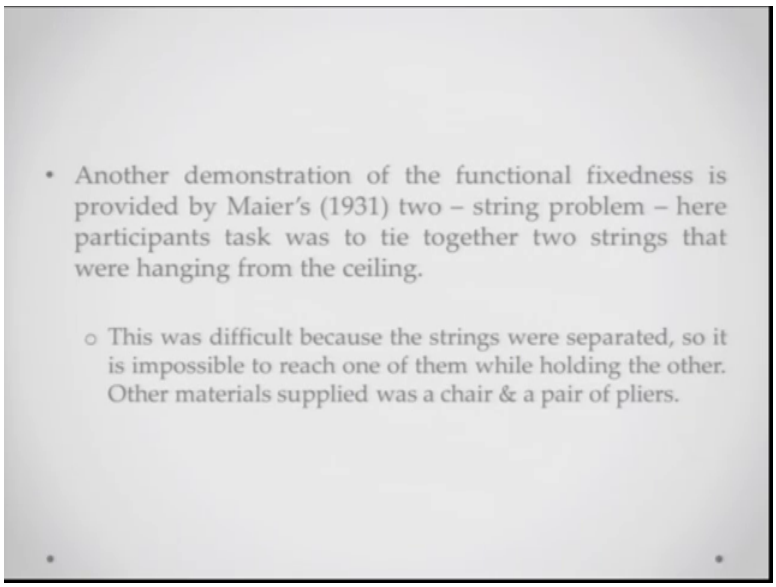

So, this is this is just a demonstration of how people think in very fixed very inflexible ways to approach problems and, sometimes kind of you know they are far worse for it.

There could be another demonstration of the same concept and this demonstration comes from Maier's to string problem and the problem is this.

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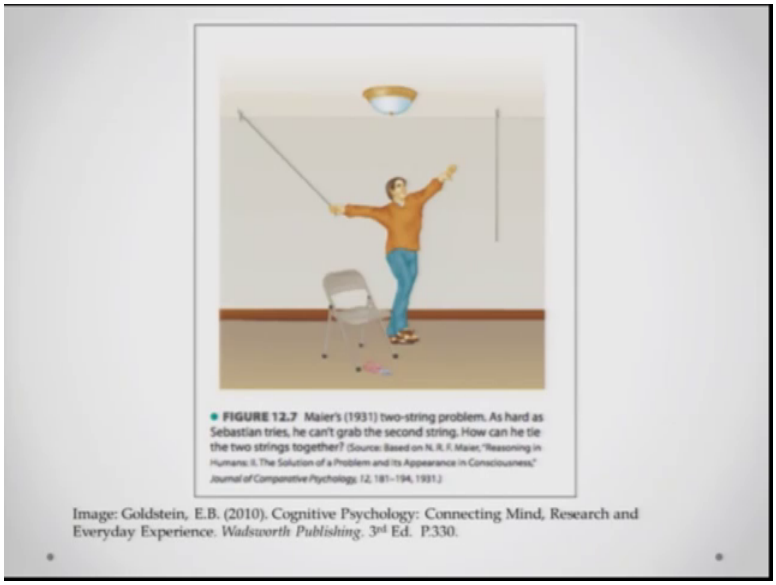

So, there are 2 strings attached to the ceiling and, there is a chair and there is a pair of pliers and, the idea is that the person has to tie these 2 strings together. The strings are created such that it is very difficult to be able to hold two of them together.

So, how would somebody solve it, this is difficult and you know it basically required some sort of innovative thinking to solve this, I am just pausing here for a minute you can actually reason out how to do it.

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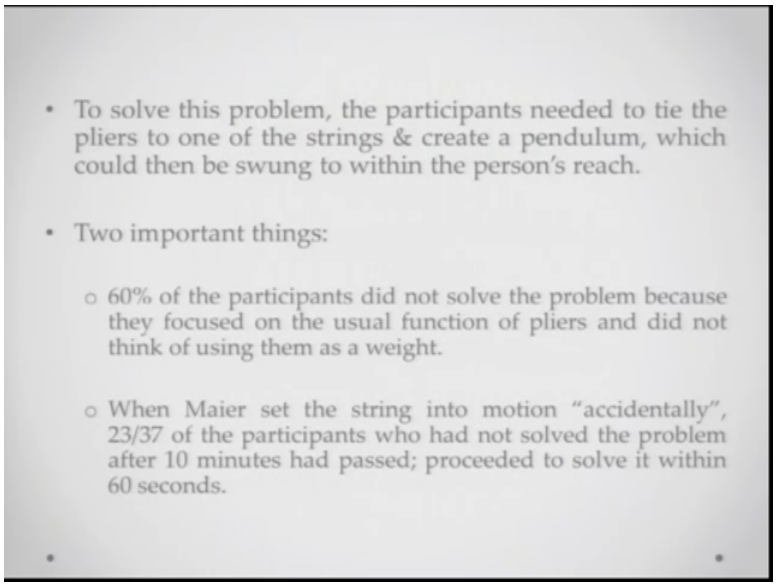

Moving on let us say solve this problem, the participants would need to actually what they needed to is to tie the plier to one of the strings and this create a pendulum and just remove the string, when one of the string moves the participants could already be holding one of the other strings and just link it using the pliers. So, the idea is you can just you know when these strings are moving towards each other, they are going to cover a lot of distance and, then they can come close to each other.

Where you can actually tie them, two important things happened in this experiment 60 percent of the participants could not solve the problem because they focus on the usual function of the pliers and, did not think of using the pliers as weight, using which the strings could be swung. When Maier said the string into motion accidentally you know just to give them a clue 23 out of the 37 participant who had not really solved the problems after even 10 minutes is us, proceeded to solve it within 60 seconds as soon as the clue was there, they saw that the strings could move and when they move they could come closer to each other, they could actually solve this.

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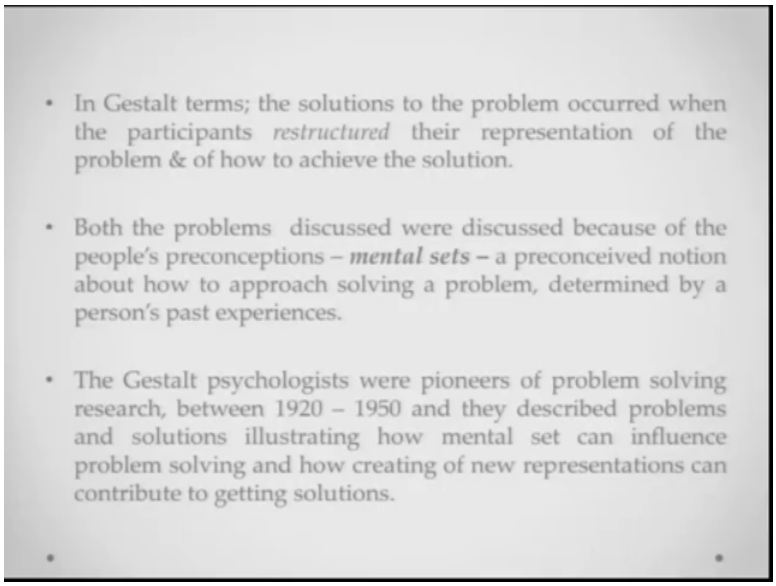

So, in gestalt terms what is happening the solutions of the problems are occurring, when the participants are restructuring their representation of the problem and of also how to achieve the solution. Both the problems discuss were discussed because of peoples were basically difficult because, of peoples preconceptions. Their mental sets you know a preconceived notion about how to approach solving a problem, that is determined by a persons previous experiences.

If your previous experiences are kind of you know in some sense making you very inflexible unable to you know look at different possible options, then there is a high chance that your problem solving strategy will be less effective more time consuming giving chance of more errors etcetera. The gestalt psychologists were pioneers of problems research between 1920s and 50s, they described a lot of problem problems and solutions and the kind of illustrated how mental states can influence problem solving and, how creating of new representations, or restructuring you know the given representations can contribute to getting solutions.

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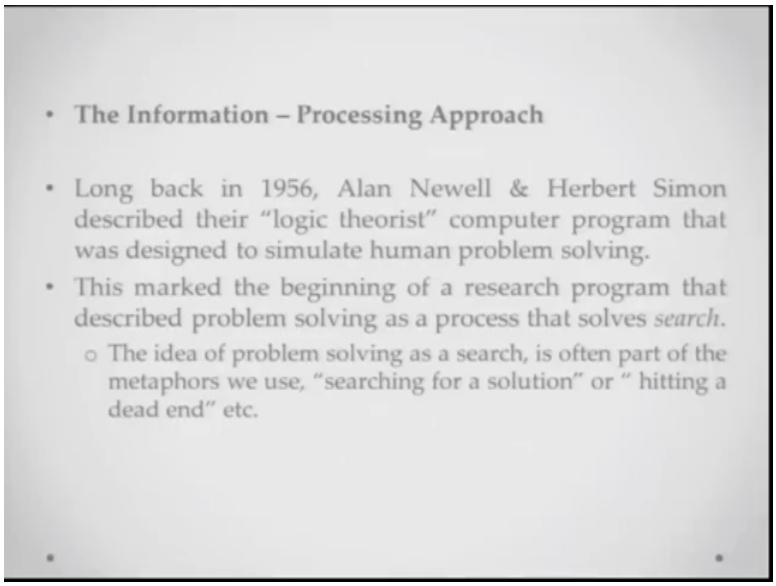

Let us move on to a different approach now, the information processing you know approach the information processing paradigm, started long back around 1956 when Alan Newell and Herbert Simon, they described their logic theorist program.

So, the logic theorist was basically a computer program which was designed to simulate human problem solving, this basically marked the beginning of a research program, that basically thought that you know that problems could be solved using search mechanisms, you know and it is not really unnatural to think of you know solving a problem as a search mechanism, we all the time we are using words like I am searching for a solution, or I am hitting the dead end in my search for a solution.

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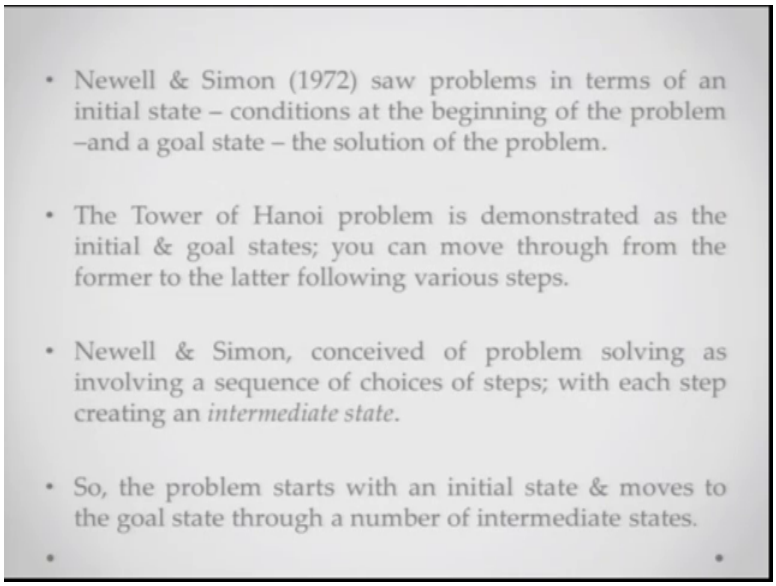

So, people generally do talk about it. So, what Alan Newell Herbert Simon did was this they conceived of solving a problem as searching for a solution and, in that sense they basically devised a way of looking at how a problem has to be solved, in terms of an initial state I have been talking about this again and again, an initial state which is conditions at the beginning of the problem and, goal state that is the eventual solution of the problem. Now we will talk about this initial in goal state using the tower of the Hanoi problem.

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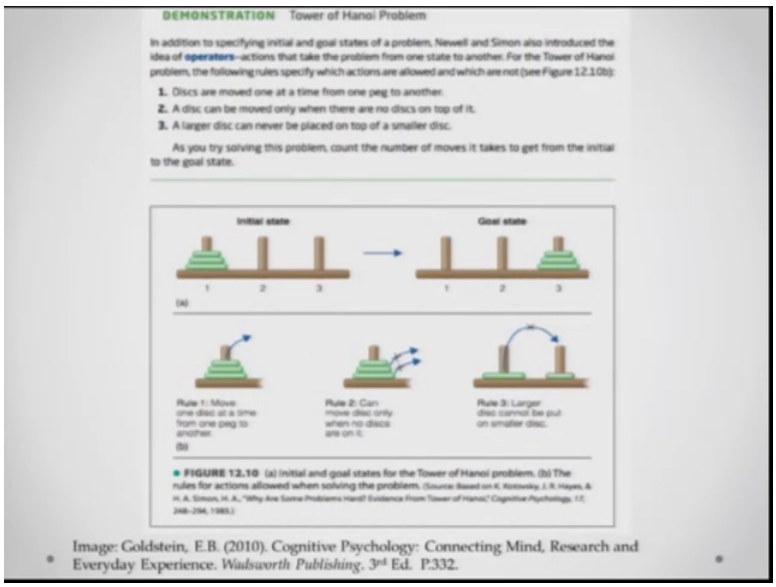

Image: Goldstein, E.B. (2010). Cognitive Psychology: Connecting Mind, Research and Everyday Experience. *Wadsworth Publishing*. 3rd Ed. P.332.

And if you know this is what the tower of Hanoi problem is there are 3 you know poles and one of the poles pole 1 has three pegs arranged in ascending order of size and, the goal state is basically that you have to move the pegs to the last pole to the last pillar using particular rules. And the rules are specified lists are to be moved one at a time from one back to another a disk can be moved only, when there are no disks on top of it, and a larger disk can never be placed or a smaller disk.

So, this is the initial state is here, the goal state is here, the rules are defined and, now what you have to do is you have to move from the initial state to the goal state using these particular steps and, keeping in mind the following rules.

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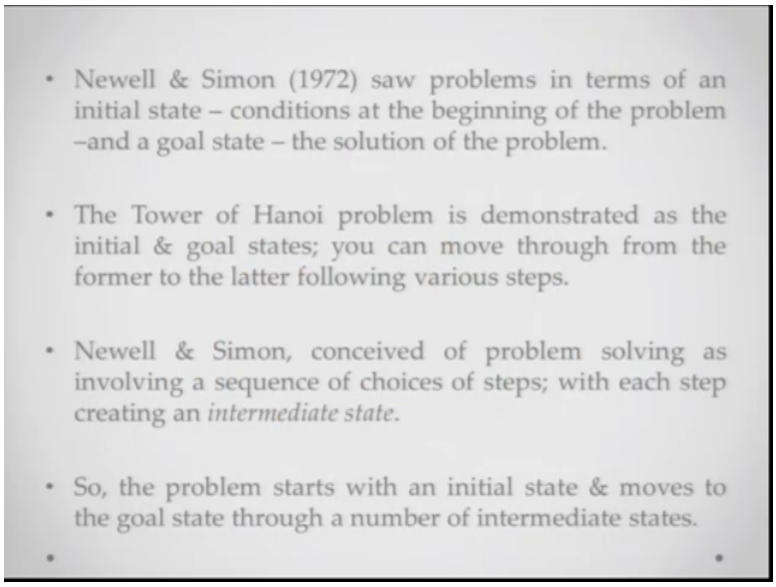

Now this tower of Hanoi problem basically, you know was conceived by Alan Newell and Herbert Simon as you know a sequence of steps. So, the idea is that there is an initial sate and there is a goal state and, there have to be a lot of intermediate steps and states. So, each step you take you end into an intermediate state and, then you know you are what you are doing is eventually, if you remember the means and heuristics eventually each of these steps will take you closer to the goal state. So, the problem starts with initial states and you have to make these steps.

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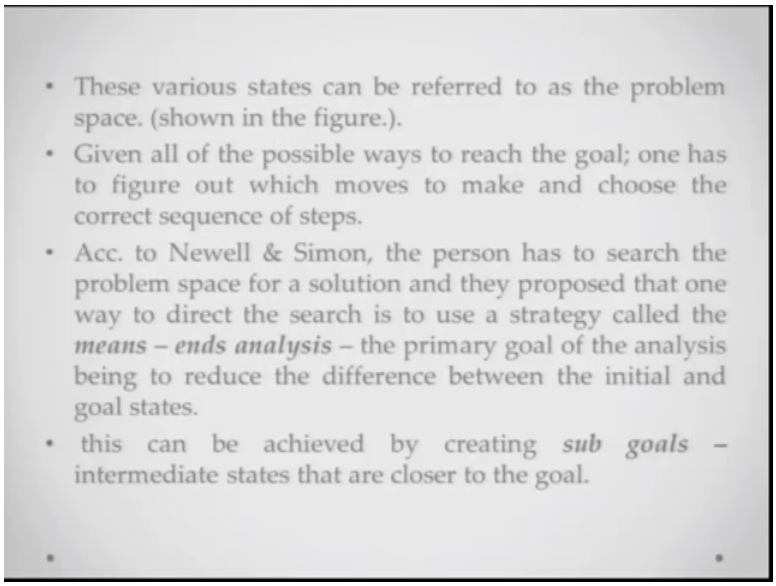

Now the various states the intermediate states, here can be referred to as the problem space, I will just show you the problem space in a bit, this is what the problem space looks like.

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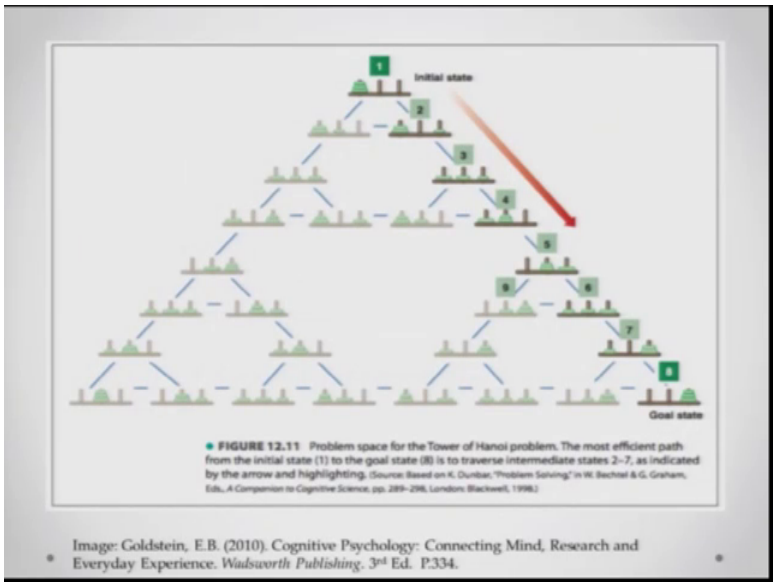

These are all the possible initial states built together and what you have to do is you have to start from 1 reach 8, which is a solution and just note a lot of times people would not have visualized all of the problem space. So, basically what they are doing is they are kind of moving in a sort of a defined problem space, which by the way they are not really

aware of what, they have to do is it is like almost moving in the dark moving from the initial to the goal state by taking some intermediate steps.

So, given all of the possible ways to reach the goal what the task of the problem solver is to figure out which moves to make and choose the correct sequence of steps. Because that is what is going to take them to the goal state in the shortest amount of time, now according to Newell and Simon or the person has to do is the person has to search the problem space for a solution, what are the different possibilities that can be considered what are the different moves I can make which of these moves will make the distance lesser which of the moves will take me further from the solution which of the moves will take me closer to the solution.

Now how is the person how is the problem solver suppose to do it, the problem solver according to Newell and Simon, does what is called means ends analysis it is very similar to the means and (Refer Time: 24:45) we have been talking about in the earlier lecture. So, what the problem solver does is it does a means ends analysis, that is it kind of figures out and you know figures out a way and the primary goal of this analysis is to be able to reduce the distance between the initial and the goal states.

So, the idea is how is this person going to do it, the person will again create sub goals or intermediate states and, he has to move from one intermediate stage to the other intermediate state, all the way towards the goal state and, the distance is being reduced. So, you can see here. So, the participant basically has to move from 1 to 2 to 3 to 4 to 5 and, then towards 9 and towards eight which is the final state.

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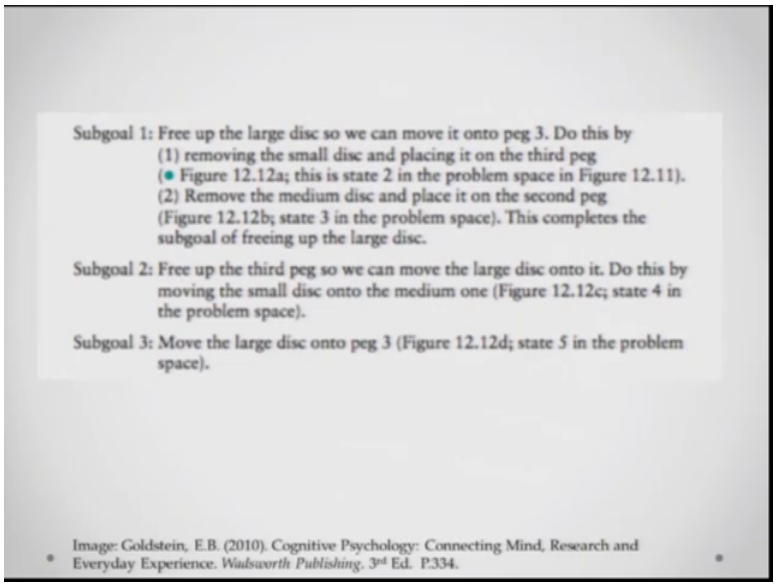

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There could be different kinds of sub goals that people can actually make suppose and just kind of borrowing and to demonstrate this. So, the sub goal one could be you know you have to first free up the largest. So, can you can move it to the big 3. So, the largest has to be moved first and, then you can just basically do it by you know, if you just look at here the idea is you have to first free the large disk.

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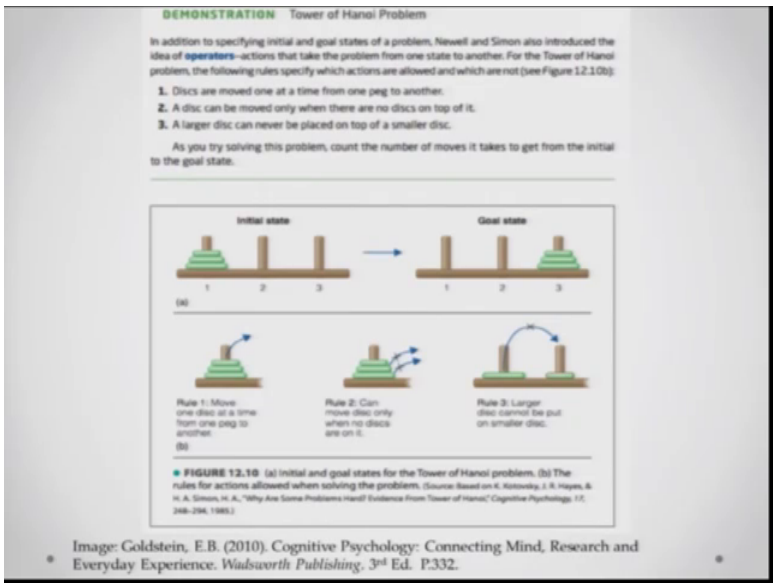

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So, what you can do is you move one of the disks to you know you move the smallest disk to peg 2, then you know you kind of move it further. So, that the large disk is free to

move to the last peg. So, let me just read out the kind of steps. So, removing the small disk and placing it on the 3rd facts or smallest it goes to the 3d peg, then remove the medium disk and move it to the 2nd peg and, then you know this completes the sub goal of freeing the largest, you know the largest is free. Now you can move it wherever you want, but there is a rule that a larger disk cannot be placed on top of a smaller disk.

So, how will you do it? And the second thing is you have to know free of the 3rd peg because, this is where the largest has to come. So, what you will do is you will pick up the smallest is from the peg 3 put it on peg 2, because peg 2 has the medium disk. Now on top of that you can pick the keep the smaller disk, once that is there peg 3 is free now you can move this to the you can move this largest is from peg 1 to peg 3, this is one way done. Now what you can do is you can just pick up the smaller disc keep it back and peg 1, you know pick up the median disc keep it on peg 3 and, then bring the smallest is on peg 3, this is basically a very quick solution to the tower of Hanoi problem, but it is; obviously, a complicated problem once you start, you know dealing with it in steps and start figuring this one out.

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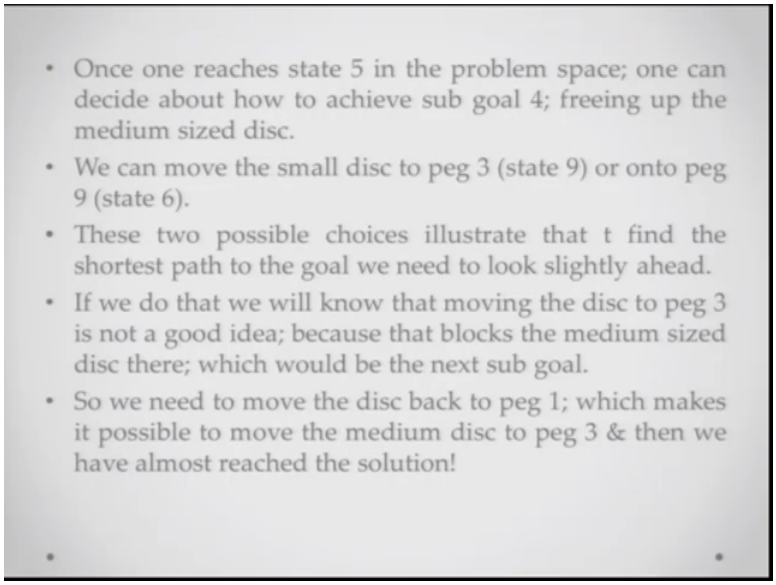

So, again this is just a description of how the problem has to be solved. So, once one reaches stage 5 in the problem face 1 can decide about how to achieve the sub goal four that is freeing up the medium size disc. So, once you have kind of done a particular steps and you kind of take a pause step back see now how are you going to free this middle

disc and, how are you going to move it. We can and there are two possible options, you can move the small disc to peg 3, or onto peg onto peg 9 that is stage 6 I will just go back here.

So, when you are actually at sub goal 5 now what you have to do is you have to free up the middle disc. So, you can either move it to peg 9 peg 3 or you can actually go to goal 6. So, again you kind of have to figure out what needs to be done to eventually reach the goals that is pretty much what the thing that you have to do. Now these two possible choices the choices between moving the smallest is to a get back again to pick 3 or onto peg you know or on do peg 9 and that will be the sub goal 6.

So, if you kind of have this idea that moving you know this to peg 3 is not really a good idea because, it more blocks the medium sizes you will not put the medium size disc, but on top of the smallest disc. So, it is not really a good idea because, you know that will block the medium size is. So, what you have to do is you have to kind of move the smallest back to peg 1 as I was saying, which makes it possible to move the medium size days to peg 3 and, then you can bring the smallest disc here. So, there is if you kind of you know take a step back and look at this much more closely, there are this sequence of steps that you have to take, each step is supposed to take you closer to the final solution.

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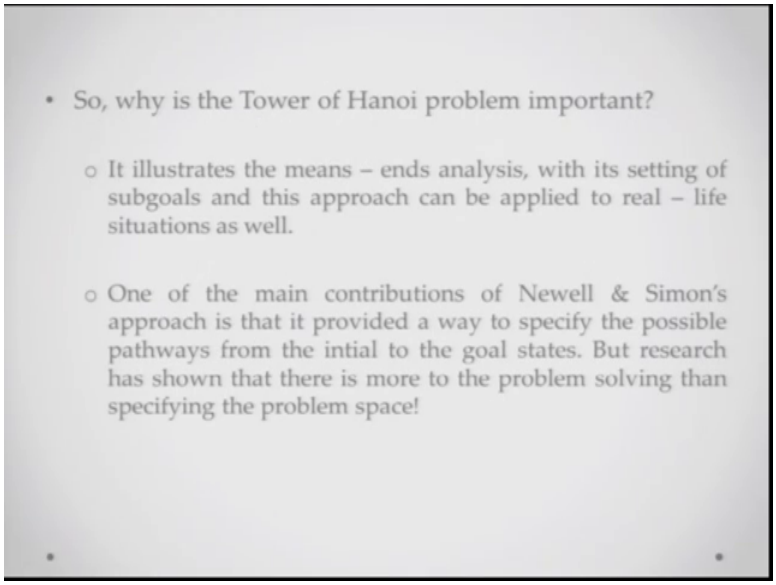

So, why is the tower of Hanoi problem important, you know the tower of Hanoi problem is important because it demonstrates the usefulness of the means ends analysis, you

know with this setting of sub goals and the approach that needs to be applied and, this is what can apply to real life situations as well. If there are bigger problems at hand if they are more complicated problems at hand, what you really need to do is draft the problems into smaller goals, and kind of you know keep achieving those smaller goals in order to eventually reach the largest goal.

That is pretty much how the means ends analysis would work out one of the main contributions, in that sense of the novel assignments you know approach is that it provides a way to specify the possible pathways from the initial state to the goal state, you take this step you are moving further from the goal state, you take this step you are moving closer from the goal state, but research basically has shown that there is; obviously, more to the you know a problem solving than just, specifying the problem space that is there are so, many other things as well.

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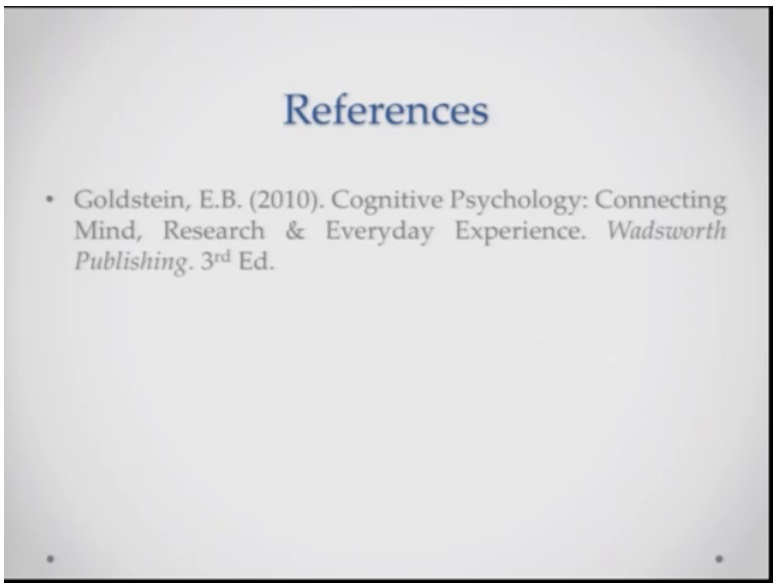

So this is all from me about the information processing approach to problem solving in the gestalt approach to problem solving, we will move to the next lecture, where we talked about some other approaches and some other aspects of problem solving.

Thank you.