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

Lecture - 29
Problem Solving – IV

Hello and welcome to the course Introduction to Advanced Cognitive Processes, this is the 6th week and we have been talking about Problem Solving in the lectures in this week. Last lecture I talked to you about strategies of solving problems, we talked basically about 2 approaches the gestalt approach and the information processing approach put forward by Alan Newell and Herbert Simon. In today's lecture as well will just take forward this discussion about problem solving approaches and, will move towards a slightly different approach to the ones we have discussed already. Now if you have wondered and, if you kind of observed the way you know people approach solving problems in real lives, one of the useful ways is to you know to approach a new problem to start thinking about a particular solution towards a problem.

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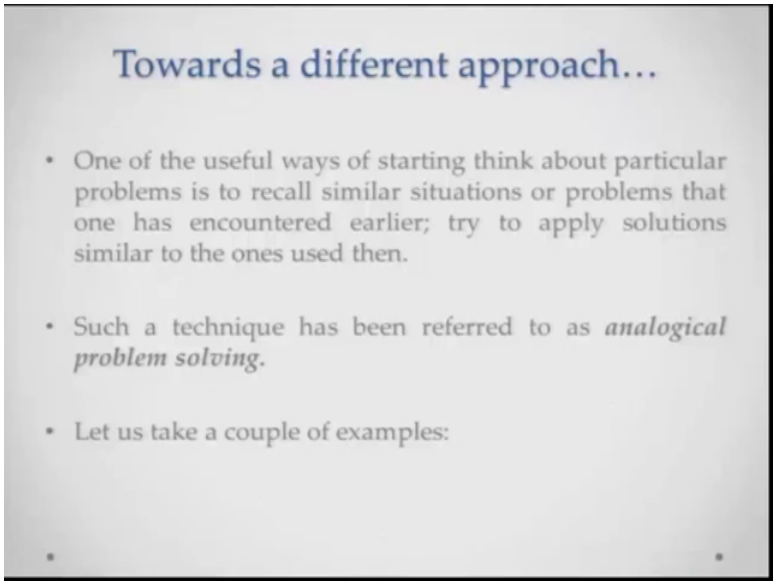

Is to you know sit back and recall some of the similar situations that you have encountered and, some of the similar problems that you have come across in the past and, then to try and apply solutions which you have used earlier to these new problems and what might happen is that your earlier experiences might help you solve these new

problems, which you know not really encountered earlier. This technique has been referred to as analogical problem solving. So, what you do is you use your older experiences or you use your older encounters with particular problems, as analogies to problems that are new and the problems that are coming up in the current time and, this analogy this you know using of this earlier problem, sometimes help you reach effective solutions to the problems at hand.

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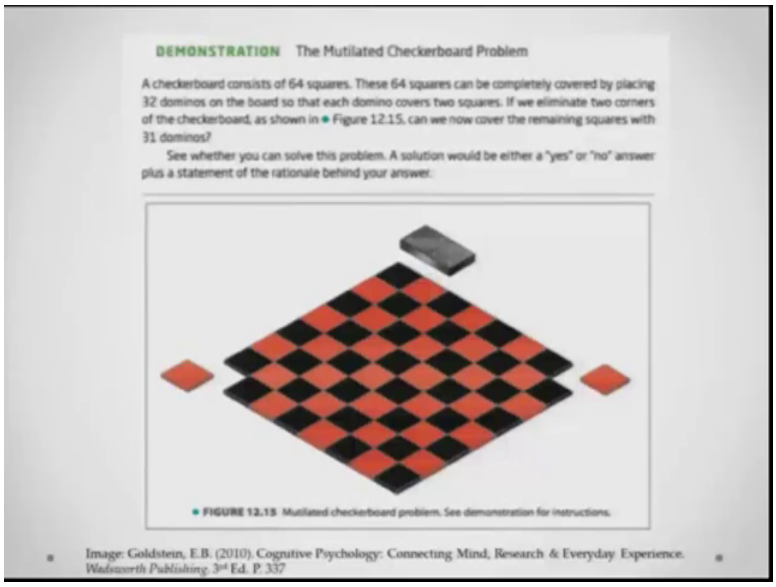

Let us take an example now there is this is the mutilated checkerboard problem and the mutilated checkerboard problem is can be stated as such and, just borrowing this for from Goldstein's book, a checkered board of 60 consists of 64 squares, these 64 squares can be completely covered by placing 32 dominoes on the board. So, that each domino covers at least 2 squares, if we eliminate 2 corners of the checkerboard as shown in the figure can we now cover the remaining squares with 31 dominoes. Now that is basically the question now you can kind of pause the lecture here, try and solve this problem, the answer is expected only in a form of a yes or a no.

So, you just you know do whatever calculation you have to and give me an answer in terms of yes or no, you can pause it and start once you have a solution in mind.

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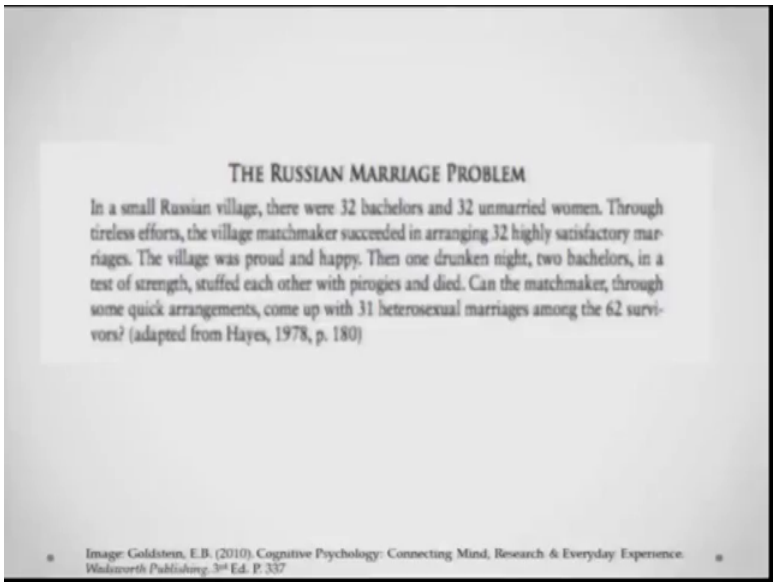

Let us move to a different problem let me let me give you a different problem now, and the different problem is the Russian marriage problem which is adopted from hayes in 1978, again I am just borrowing this from Goldstein as well, the Russian marriage problem goes like this, in a small Russian village there were 32 bachelors and 32 unmarried women, through tireless efforts the village matchmakers succeeded in arranging 32 highly satisfactory marriages. Everybody was proud and happy and the marriages were going on fine as well. And what happens one night, one drunken night, two bachelors, in a test of strength, stuffed each other with particular sharp weapons and died.

Now the idea is there are 62 people here, the question is can the matchmaker through some quick arrangements some shuffling come up with 31 heterosexual marriages amongst the 62 survivors, you know 62 divided by 2 is 31. Now just think of this problem emphasis is on heterosexual marriages 31 heterosexual marriages between 62 individuals, but remember there are 32 unmarried women and only 30 bachelors 2 of them have died. If you kind of spend a minute thinking about this, you will immediately be able to tell that, you know the answer the solution to this problem is no, it cannot really be done, now think back from here to the mutilated checkerboard problem.

If you think back at the checkerboard problem, after you have read the Russian marriage problem, you will realize very quickly that a domino cannot cover 2 species and hence

the 31 you know basically 31 dominoes cannot be able to cover the entire thing, you will still need the same number of dominos. So, this is just an example of how one kind of problem might be able to help you solve another problem, which has a rather similar structure. We will talk about how this works in the rest of the lecture today.

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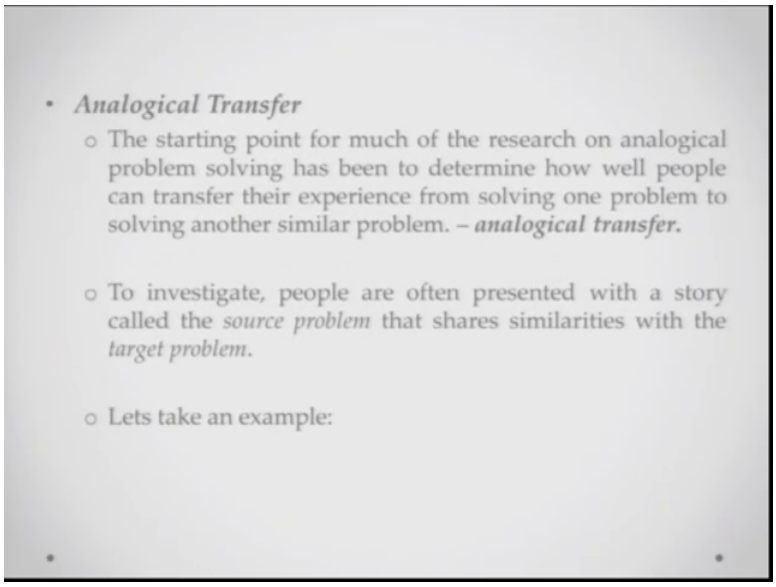

This process of you know using features from one kind of problems to different problems, is referred to as analogical transfer. So, the starting point for much of this research on analogical problem solving, has been to determine how well people can transfer their experiences of solving, one kind of problems to solving another similar problem. This is analogical transfer.

Now to investigate people are often presented with a story called the source problem and, that shares similarities with the target problem. So, the idea is similarly you can just see the earlier example, the Russian marriage you know example could be the source problem while the checkerboard problem could be the target problem, or even the other way round does not really matter, but one of the problems because it is very similar to the other problem, will help the participant can help the participant in solving these problems.

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Let us take a different example now this one is referred to as Dunckers radiation problem I am just going to read, this one out to it and then you can pause the lecture take a couple of minutes and, reason how do you want to solve this problem. So, let me just read this out again borrowed from Goldstein's book. Suppose you are a doctor faced with a patient who has a malignant tumor in his stomach, it is impossible to operate on this patient, but unless the tumor is destroyed the patient is going to die.

There is a kind of a ray that can be used to destroy the tumor and, if the ray reaches the tumor at a sufficiently high intensity the tumor will be destroyed, unfortunately there is a side effect of this, as well at this intensity which is needed to destroy the tumor the healthy tissue that the ray passes through also will be destroyed. At lower insane intensities the ray is harmless to healthy tissue, but then the tumor will not be destroyed it will not really affect the tumor either. So, the question is what type of a procedure might be used to destroy this tumor and at the same time avoid destroying the healthy tissue. this problem was used by Gick and Holyoak in 1980s, again it is it is an adaptation of the original dunkers problem, this is the radiation problem. Now you have to you can pause it give 2 minutes think of how you will solve it.

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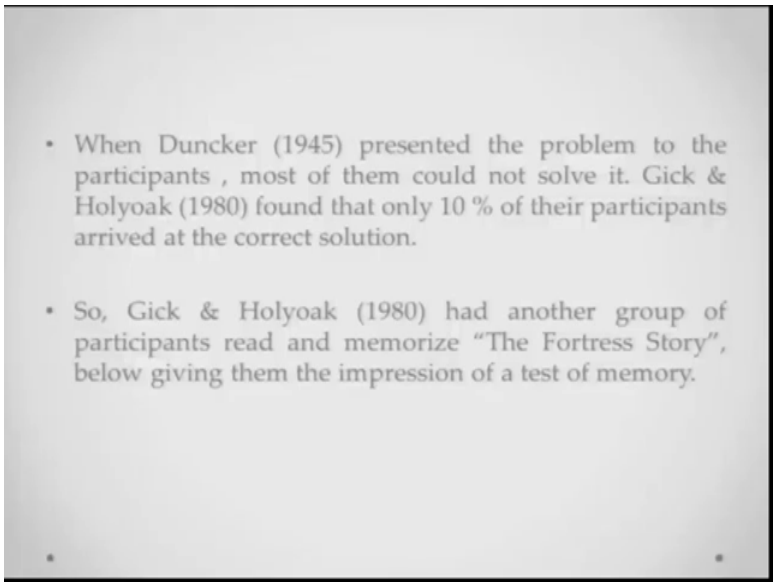

So, when Duncker 9 in 1945 presented this problem to the participants most of them could not really come up with a solution, Gick and Holyoak did this in 1980 and they also found that only 10 percent of their participants could actually arrive at the correct solution. So, what happen is that Gick and Holyoak in 1980, they proclaimed that you know this is a very difficult problem and so, then what they did was they asked their participants to read and memorize the fortress story.

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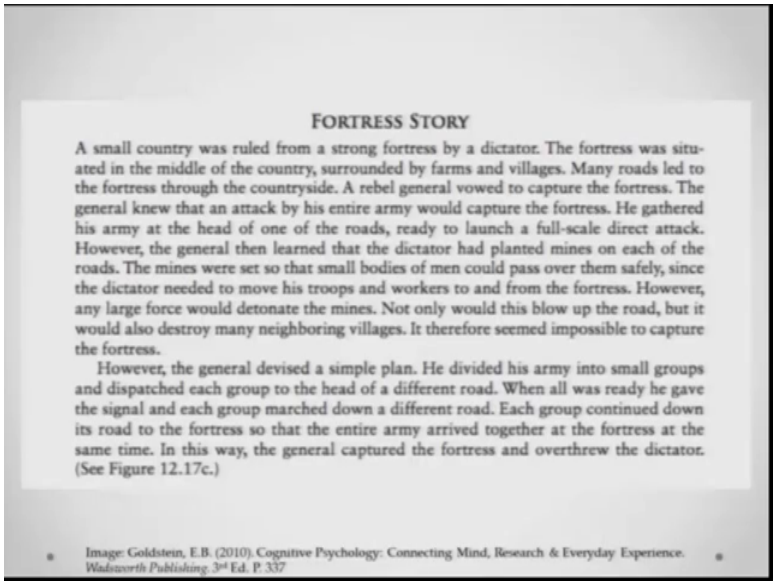

So, let us show you the fortress story and, the fortress story goes like this who can be a little bit patient the fortress story is there a small country was ruled from a strong for a small country was ruled from a strong fortress by a dictator, the fortress was situated in the middle of the country, surrounded by farms and villages many roads led to the fortress and throughout the countryside. A rebel general vowed to capture the fortress, the general knew that an attack by his entire army would be sufficient to capture the fortress. He gathered in his army at the head of one of the roads ready to launch a full state a full scale direct attack; however, the general then realizes that the dictator had planted landmines on each of the roads the mines were.

So, set such that they were small that small bodies of men could pass through them unharmed, safely since the dictator needed to move his troops and workers to and from the fortress; however, any large force any large number of men moving over these roads would detonate the minds. Not only would this blow up the road, but it will also destroy many neighboring villages it. Therefore, seemed impossible to capture the fortress now; however, what happens is the general devises a simple plan, he divides his army into small groups and dispatches each group to the head of a different road, when all were ready he gives he gives a signal to each group and each group marches down a different route. Now each group continues down to it and down the road to the fortress. So, that the entire army arrives together at the fortress and at the same time and, then they can capture the fortress. So, the general captures the fortress and overthrows the dictator, this is the fortress problem.

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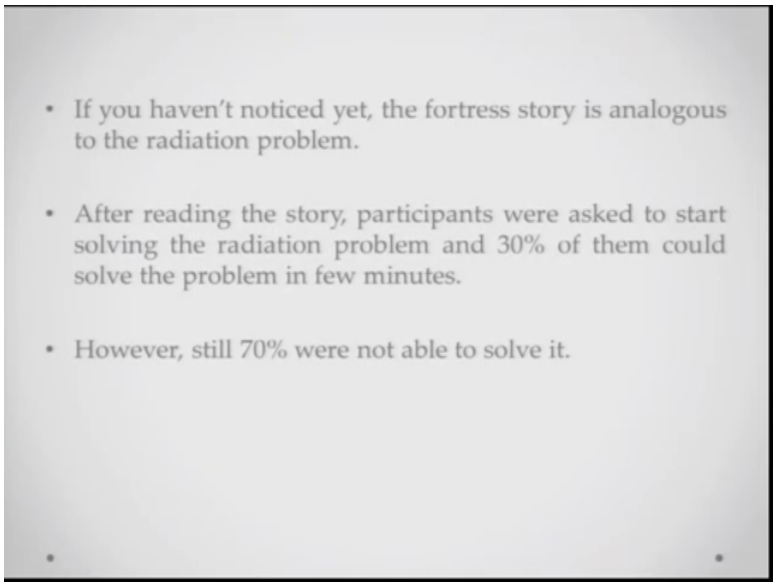

Now unless if you have not really you know noticed it yet this is rather similar to the tumor problem so, after reading this story what happens is that the participants were asked to start working on the radiation problem, this was source problem in some sense and, then the target problem was again given as the radiation problem, 30 percent of those people who had read and memorized the story, could solve the problem now in a few minutes; however, 70 percent of these participants could still not solve it.

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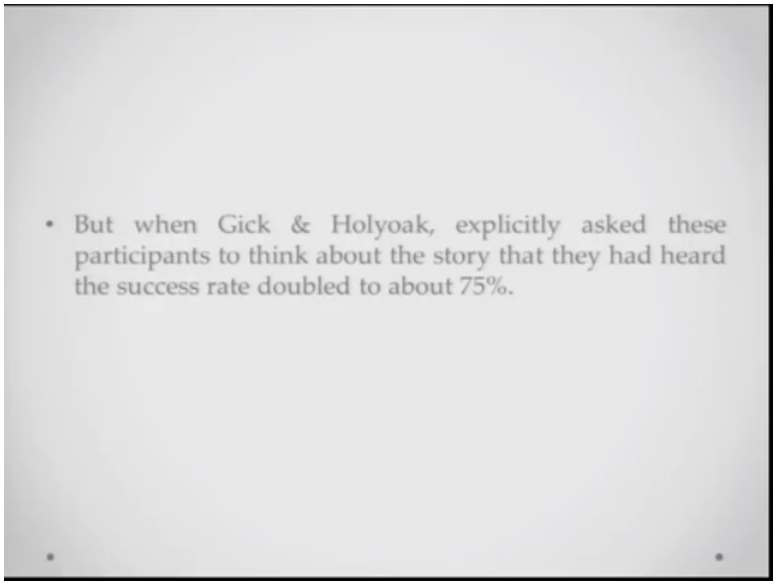

So, what was done is that Gick and Holyoak explicitly asked these participants to think about the story they had learned and, you know and use the whatever they had gained from that story in solving this problem. Now the success rate doubles and goes up to about 75 percent.

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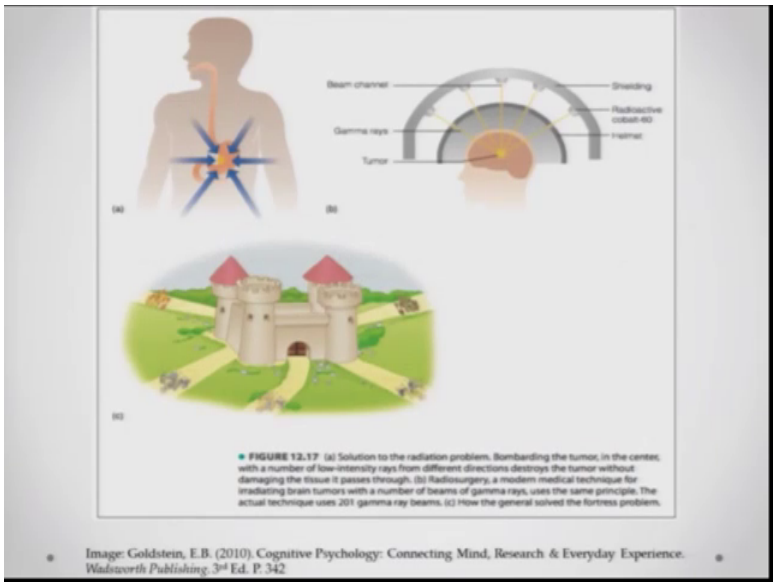

Image: Goldstein, E.B. (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing*. 3rd Ed. P. 342

So, what is happening it you basically you know the solution the radiation eh radiation problem is that you have to you know, push this these rays from different directions at smaller intensities, but all of them are reaching at the tumor at the same time and, then they will be able to destroy the tumor much as the different armies, reaching at the same time when the fortress could help capture the fortress well.

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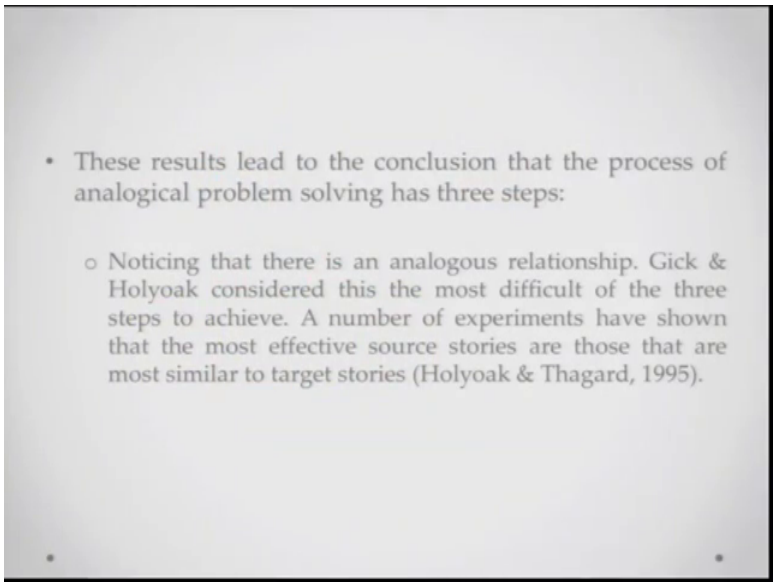

This is this is a very interesting thing you know that people learn and, the results kind of took Gick and Holyoak to a set of conclusions, they concluded that analogical problem solving in basically includes 3 major steps. The first and the most important also the most difficult step is noticing that there is an analogous relationship, if you can figure out the relationship between the current problem and, you know the problem that you aware of and the new problem at hand. Then you can start thinking of the analogy Gick and Holyoak considered this the most difficult of all the three steps to achieve and, a number of experiments have been done on this and they have shown that most effective source stories are that share most of their features with the target stories because, making this connection getting this notice is then much more easier.

So, the first task is that you realize that you notice that there is an analogous relationship between what you already know and, what the new problem at hand is.

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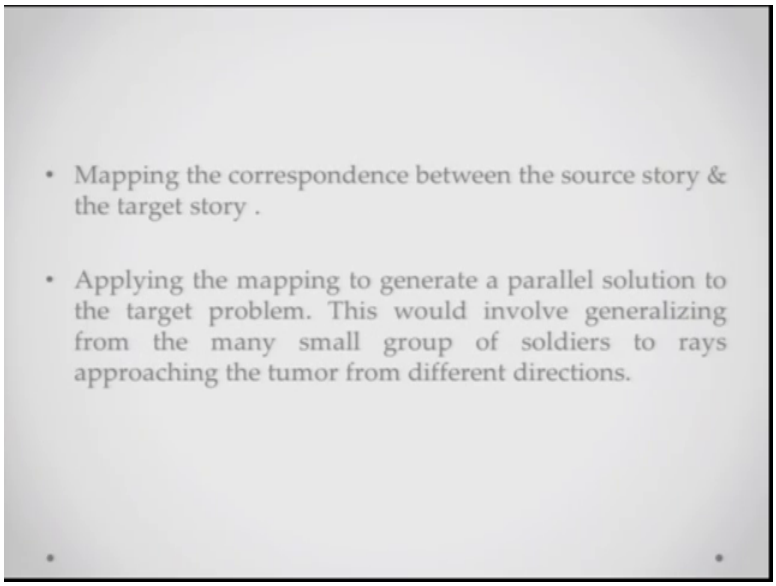

The next step is mapping the correspondence between the source story and the target story for example, the people who are reading these problems have to realize that you know the army a members the troops are basically similar to the race and, the roads are basically similar to you know different sources and, as the army reaches from different roads at the same time, the race could reach from different sources at the same time and destroy the tumor, or capture the fortress.

So, this mapping is very important and applying this mapping basically is the third step. So, applying this mapping to generate a parallel solution to the target problem that is the 3rd an another very important step. This application of or this application of the mapping and, this generation of a parallel solution would basically involve generalizing from the small group of soldiers, to raise approaching from the you know the tumor from different directions. So, if these three steps are followed is these three tips are abided by that is where analogical problem solving, or analogous problem solving will succeed.

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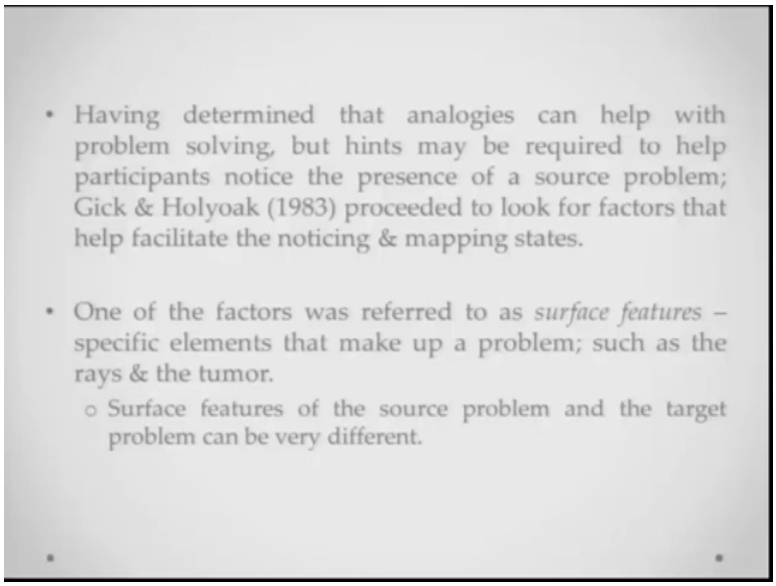

Now having determined that analogies can help with problem solving, but obviously sometimes hints are required to help participants notice these map, notice there is a relationship and notice you know the presence of a source problem in their experience, Gick and Holyoake proceeded to look for factors that help facilitate this noticing and mapping, you know that help making this connections. So, one of the factors was referred to as surface features. The surface features is basically the specific elements that make up the two problems, such as the rays and the tumor and the rays and (Refer Time: 13:52) those kind of things, the surface features of the source problem and the target problem can sometimes be very different.

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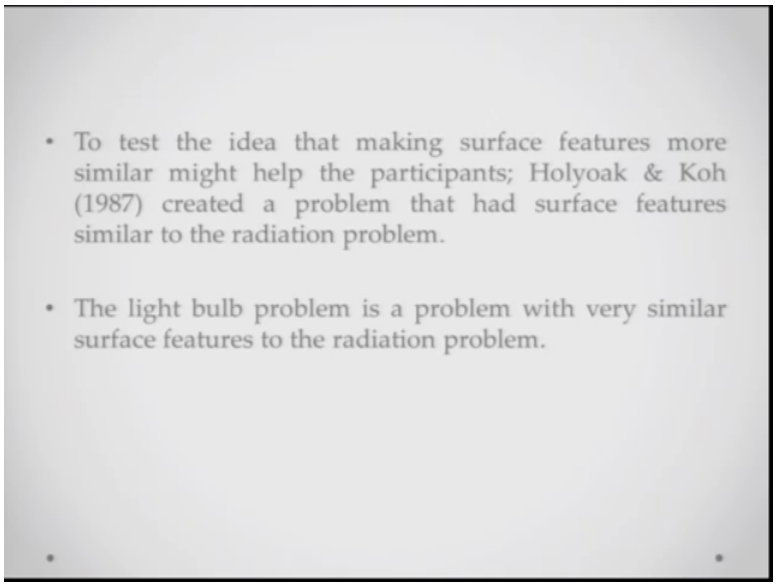

To test this idea that making surface features more similar might help the participants, Holyoak and Koh in 1987, they created a problem that had similar surface features to the radiation problem.

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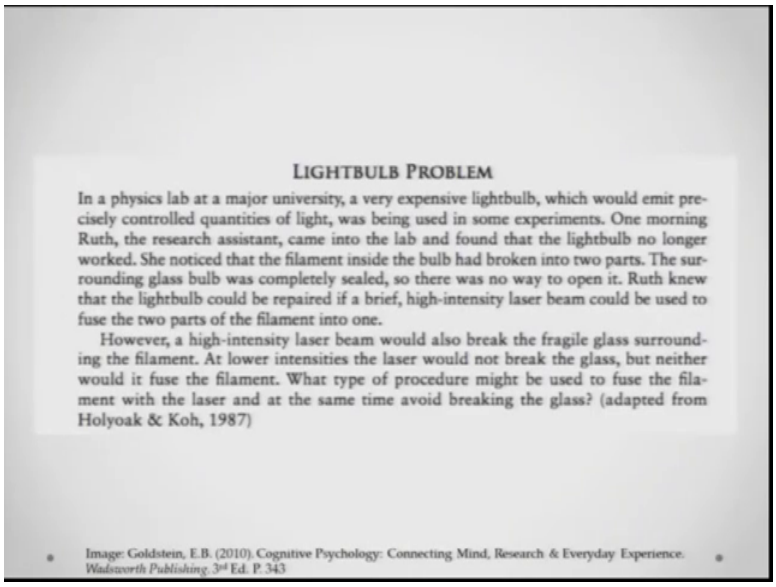

The light bulb problem was is a very similar problem to the you know a radiation problem and, this goes like this in a physics lab at a major university a very expensive light bulb, they use a very expensive light bulb which would emit precisely controlled qualities of light and, they it was being used in a lot of experiments, one morning Ruth

the research assistant comes into the lab and finds a light bulb no longer works. She notices that the filament inside the bulb had broken into 2 parts. This the surrounding glass bulb was completely sealed.

So, there was no way to open it Ruth knew that the light bulb could be repaired, if a brief high intensity laser beam could be used to fuse the 2 parts of the filament together; however, a high intensity laser beam would also break the surrounding fragile glass, surrounding the filament, at lower intensities the laser would not break the glass, but then it will not fuse the filament together as well. Now the question is what type of procedure might be used to fuse the filament and the layer filament with the laser at the same time avoiding breaking the glass.

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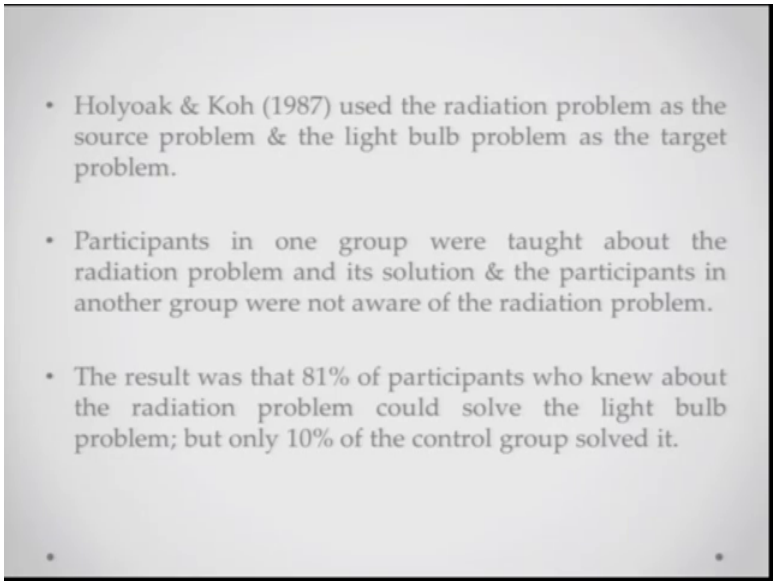

Again if you just spend a minute reading that understanding that this is very similar to the radiation problem and, when participants were giving this one group of participants were taught about the radiation problem and it is solution in a psychology class and, another group of participants were not really aware of the radiation problem. So, what they found was that 81 percent of the participants, who knew about the radiation problem could very quickly solve this light bulb problem, but only ten percent people of the control group could solve this problem.

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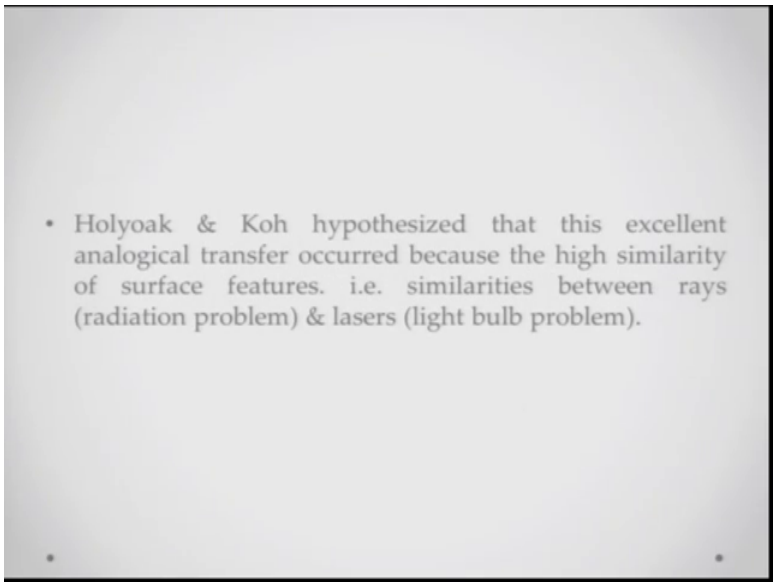

So, what is happening here Holyoak and koh hypothesize that this excellent analogical transfer is occurring because, there is a high similarity of surface features between the two problems, you know radiation problem and the rays in the radiation problem and lasers in the light bulb problem.

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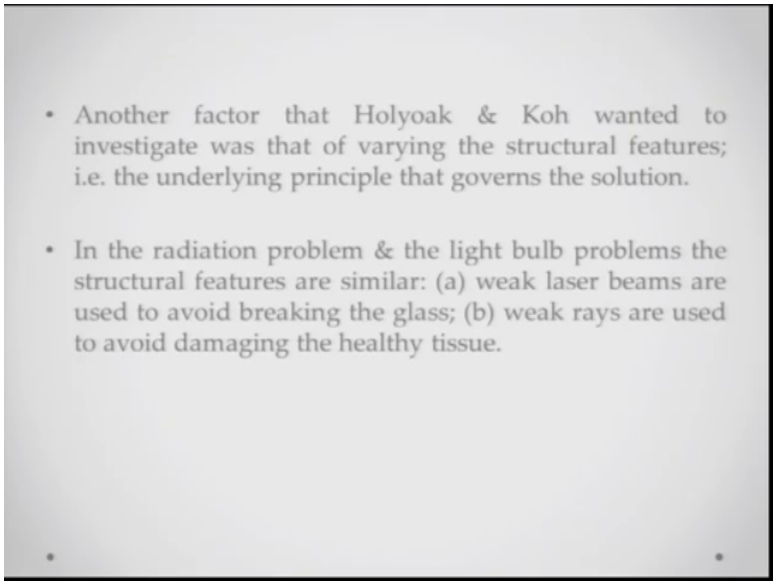

Now so, you know surface features similarity is very important, another kind of similarity should be was investigated and this was the similarity between structural

features. Now structural features are the underlying principles behind a particular solution that govern a particular solution.

So, what they did was the radiation problem and the light bulb problems structural features are also similar, you know the weak laser beams are used to avoid breaking the glass and, the weak rays are used to avoid damaging the healthy tissue. So, these are aspects of the solution that are similar.

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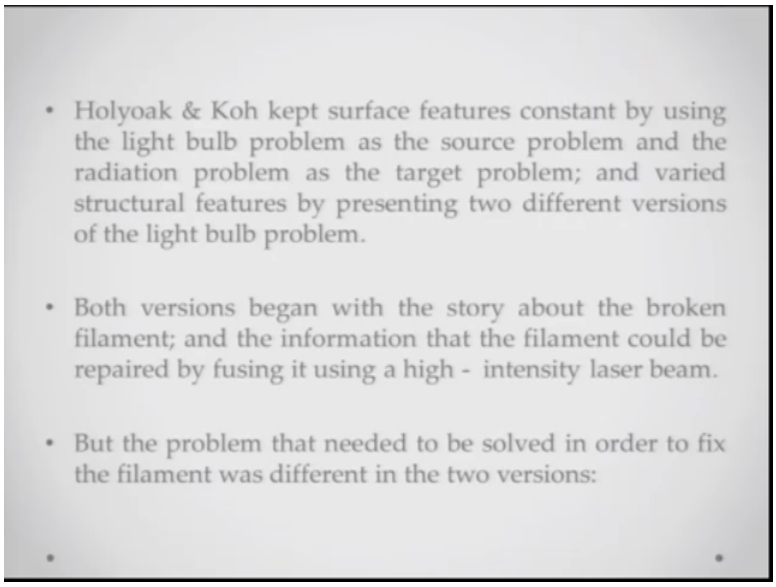

So, Holyoak and Koh kept the surface features constant by now using a light bulb problem, as the source problem and the radiation problem as the target problem and, what they did was they tried to vary the structural features by presenting 2 different versions of the light bulb problem, both versions began the story about the broken filament and the information that the filament could be fused using the high intensity laser beam was given, but the problem that needed to be solved in order to fix the filament was different in the 2 versions.

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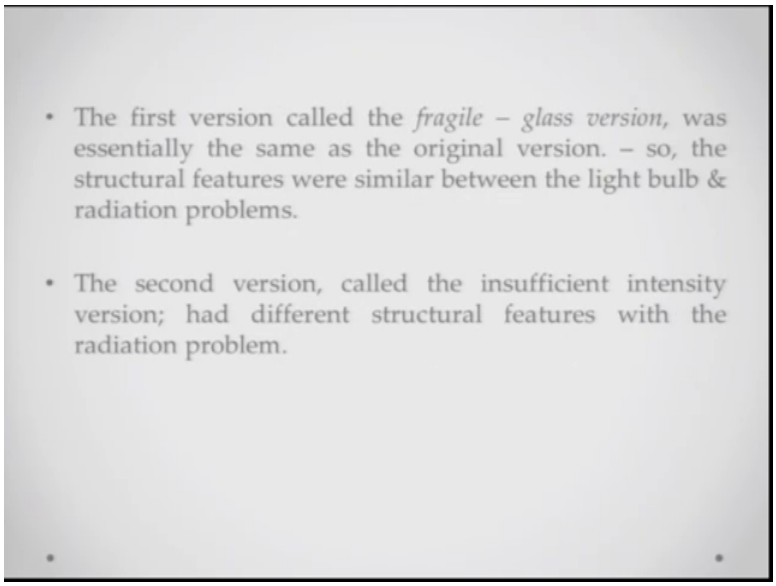

So, I will just read you out the 2 versions the first version is the fragile glass version, it is essentially same as the original version. The second version is called the insufficient intensity version; it had a different structural feature I will just read that out to you.

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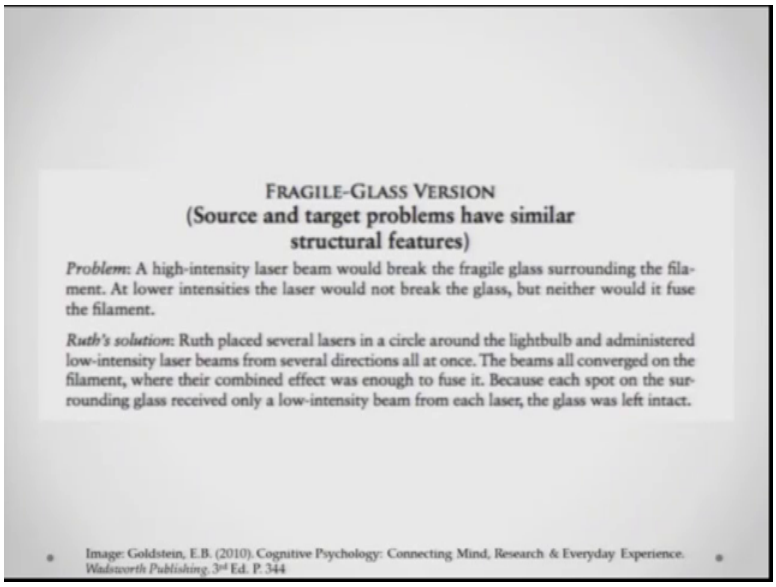

So, the first version is exactly same so, Ruth placed several lasers in a circle across the light bulb around the light bulb and, administered low intensity laser beams from several directions all at once the beams all converged on the filament, when their combined

effort was enough to fuse it because, each spot on the surrounding glass received a low intensity beam the glass was also not broken.

Now let us move to the next version of the problem today the problem, is laser generates only low intensity means that were not strong enough to fuse the filament. A much more intense laser beam is now needed again, there is a same thing. The Ruth solution now, is Ruths Ruth places several lasers in a circle around a light bulb and, administered low intensity laser beams from several directions all at. Once the beams all converge on the filament where their combined effort was enough to fuse it, now the solution is slightly you know different here, the glass aspect is not there.

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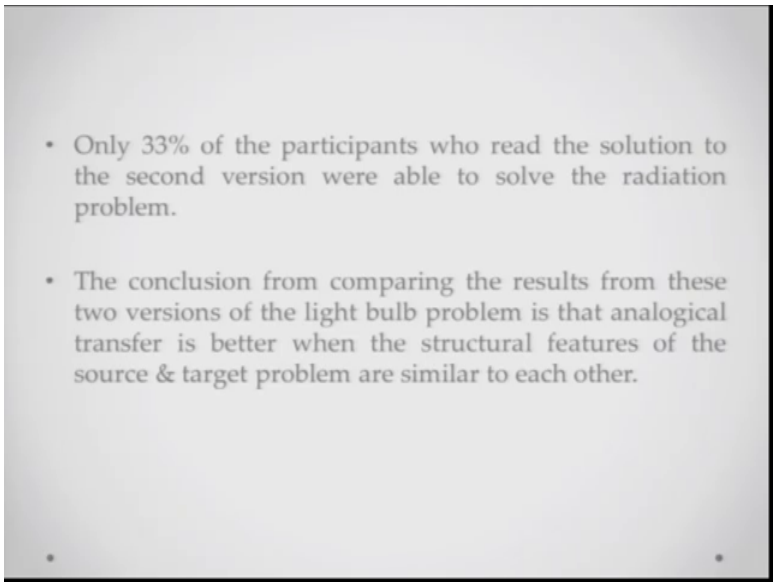

Only 33 percent of the participants who read the solution to the second version, where now able to solve the radiation problem, those aspects of the solution have been taken away you know the healthy tissue thing has been taken away. The conclusion from comparing the results from the 2 versions of the light bulb problem, is that analogical transfer is also far better when the structural features of the source and target problems are very similar to each other.

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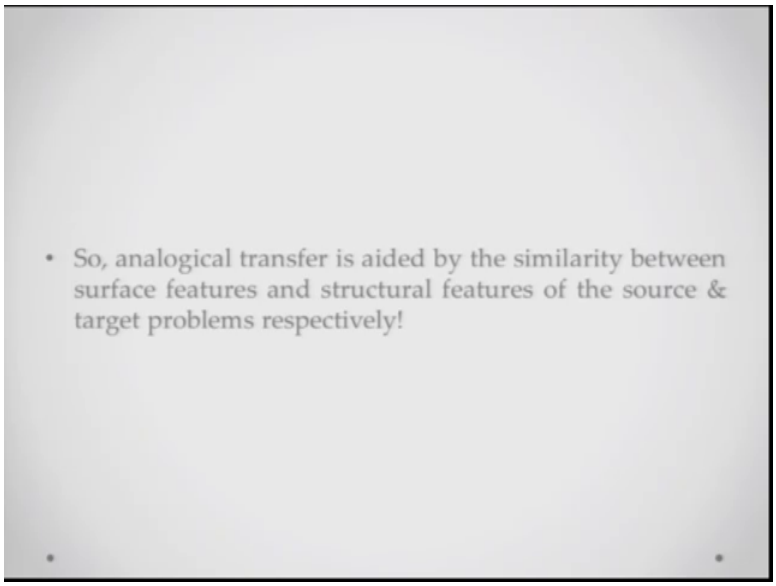

So, both kinds of similarities is basically are going to help ensure the analogical transfer.

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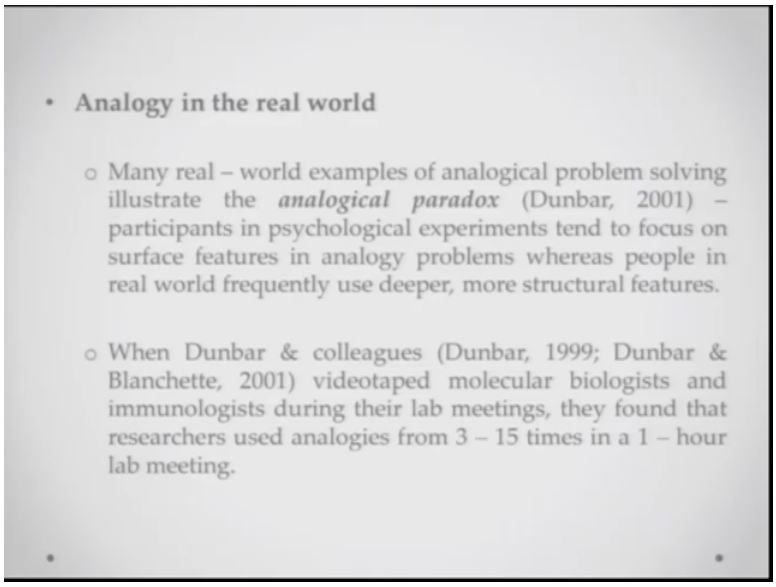

Now again as I was talking earlier, you know analogy people use analogy all the time people use analogous problem solving all the time. There are many real world examples of analogical problem solving, they referred to as the analogical paradox, as referred to by Dunbar in 2001, he saw that participants in psychological experiments tended to focus on surface features in analogy problems, there is people in real life they frequently use you know much deeper and much more structural features, how the solution is attained

say, when Dunbar colleagues they were videotaping the conversations of molecular biologists and immunologist, during their lab meetings they found that the researchers use analogies from 3 to up from 3 to up to 15 times in just a one hour lab meeting. So, people are kind of making these very deep connections almost very frequently.

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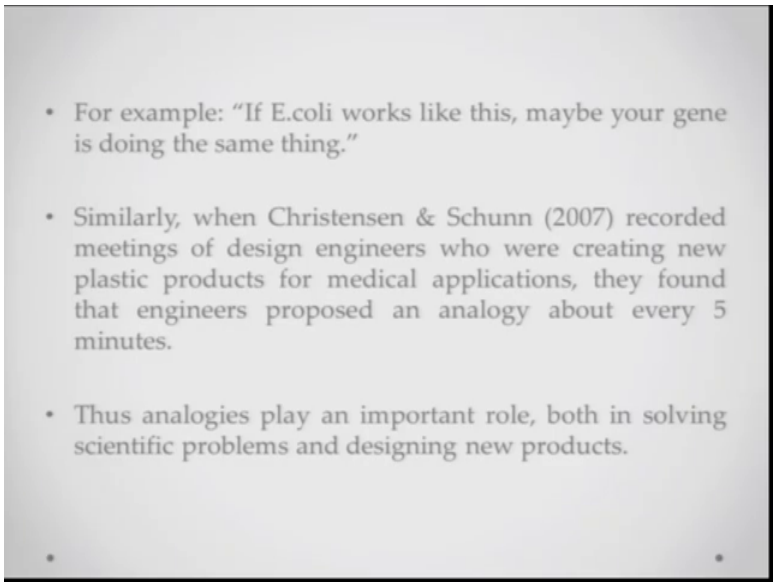

For example, and the things could be like for example, if E coli works like this maybe your gene is also doing the same thing. Similarly when Christensen and Schunn they recorded meetings of design engineers who are creating new plastic products for medical applications, they found that these engineers also proposed an analogy, almost about every five minutes. So, they are also making all of these connections. So, you can see that analogies play a very important role both in solving scientific problems and designing new products.

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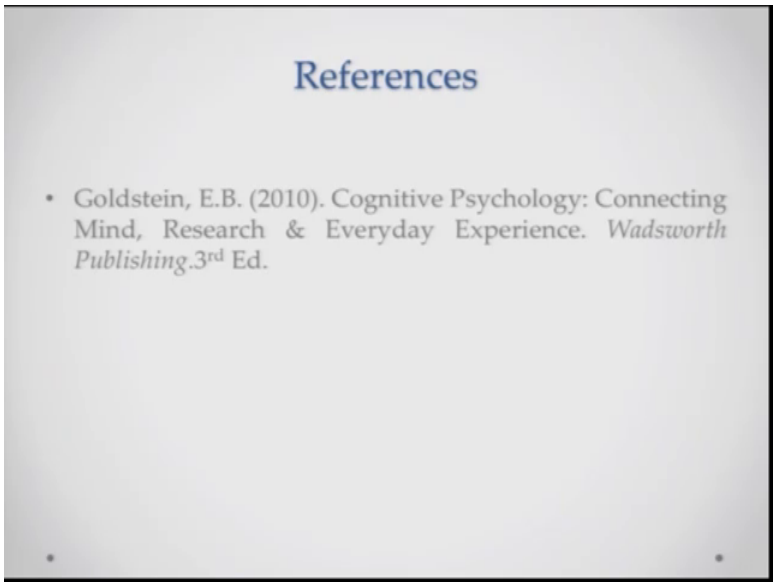

This is all from me about analogical problem solving; you will talk about a new aspect of problem solving in the next lecture.

Thank you.