Introduction to Professional Scientific Communication

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Lecture – 02
Where do research ideas come from?

Welcome back to this course Professional Scientific Communication.

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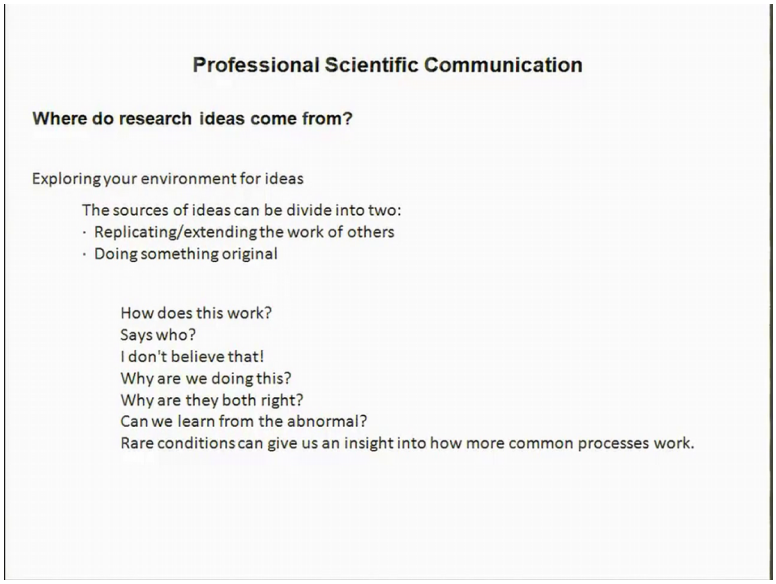

So, in this lecture today we are going to look into an important question that is where do research ideas come from? Because these are you know; this particular topic is very important because how good your research is, how good your research question is depends on what question you are asking or idea that give sort generated to address in your scientific project.

So, the question is where do research ideas come from. One obvious aspect of generating ideas is that you should explore your environment ideas; it is everywhere. So, that, but you have to observe, you have to ask question that is extremely important. The source of the ideas can be divided into two broad category; one that you do a literature survey, you read about a given topic and then you redo some of the experiment that people have done to see whether that can be validated, if you have any doubt and then you can extend the existing knowledge by adding few experiments, adding few more question therefore, you contribute to the knowledge base.

So, that is one that is very very common because you know research being too complex in your stay as a graduate student; as a PhD student or if you have taken up a 3 year, 4 year project; you will not be able to add substantially too much because you know the complexity of the problem that you have taken. So, therefore, what you do is an incremental knowledge; you act to existing knowledge by following what has been done before; what questions are not addressed and how to address them and why should I address them and then how that may contribute to the advancement? So, that is what you do most often in a PhD or in a master thesis that is what we do.

But at times we can also do something absolutely original; nobody has asked this question before I have looked into and I have done this; this is far more challenging, but worth you know pursuing you are going to start altogether a new research, topic or you are going to come up with certain product that could be of great benefit to the society and so, on. o, doing something original though risky is worth considering.

Let us see how do you really go about asking these questions and how do you generate ideas? You should ask questions, questions are extremely important for scientific research ideas. You should ask how does this work? Says who? Somebody said something; would you believe, you need to go and look at what is the reason that he or she said.

So, what experiment that person has done to say so, was it based on certain principle, was it based on certain observation? If it was just like that then you should not consider that; it is not that anything and everything that is written is correct. So, you need to question I do not believe that; that is the way you test, you take for granted it is not going to work.

So, you have to sometimes; if you cannot sort of go with the assumptions and the observation somebody made, you can re do the experiments and then see whether it is you know coming out the same way. Another important question why are we doing this? It is equally important because just because somebody asks you to do something, you should not do; you have to ask question is it really make any difference if I do this experiment? If your answer is yes; you should do.

Why are they both right? There could be two different outcome of an experiment; somebody had done this, you have done this. So, both outcomes; you have used very

similar approach, but the outcome is different. Then why I mean if it is (Refer Time: 04:22) then you need to ask question has to why both these observations could be right? So, need to again look into; that most often at least in bio medical research, we learn a lot from abnormalities.

So, if you look into for example, any disease or a developmental disorder; all these are abnormalities. That is how you learn has to how things work; so, abnormalities really help for example, you must have seen people with sixth finger; it is an abnormality, but we go out and look into the genes involved in that and identify the gene that is defective, which tells you now that this is the gene that is involved in for example, the digitsl formation of your hands, legs and so, on; so, that is an abnormality that is what help you.

Again rare conditions can give us an insight into how more common process work, often this is a notion that you are looking into something that is rare; which is not relevant, which is not the case. Most of the phenomenal discoveries that have been made in; for example, in biomedical research how come from rare examples. The examples may be rare, but the outcome of that could address a more common processes.

For example, people talk about Alzheimer, Parkinson's and so, on these are dementia and these are the disorders that affect the aged population, but do we know exactly what causes these conditions? This particular understanding possibly, this is the process that goes wrong as a result you may have this condition comes from some rare forms of genetic disorders, which also result in symptoms which are very similar to more common forms of disorders. So, the rare forms really help us; so, the rare forms really help, so you should not neglect simply because there are rarer therefore, they need not have any relevance to the society.

So, these are some of the example; so, you need to ask questions just do not go blindly by somebody saying that, you need to ask questions, you have to have discussions and then sort of convince yourself that what is saying is right; that I should do or that what he is saying is not right I should not do this, but I should do something else. So, this something that you need to take judgment; for this you really need to discuss, debate with people you know who have done that kind of research; because they have more experience. You may have very good question and you probably may not get a solution because the problem is to too complex and you do not have a tool to you know dissect

that. So, that is called practical right; you cannot really get into that problem because you do not have tools right now. So, you have to wait for it; who will tell that you cannot address this; is somebody who was done that kind of a research.

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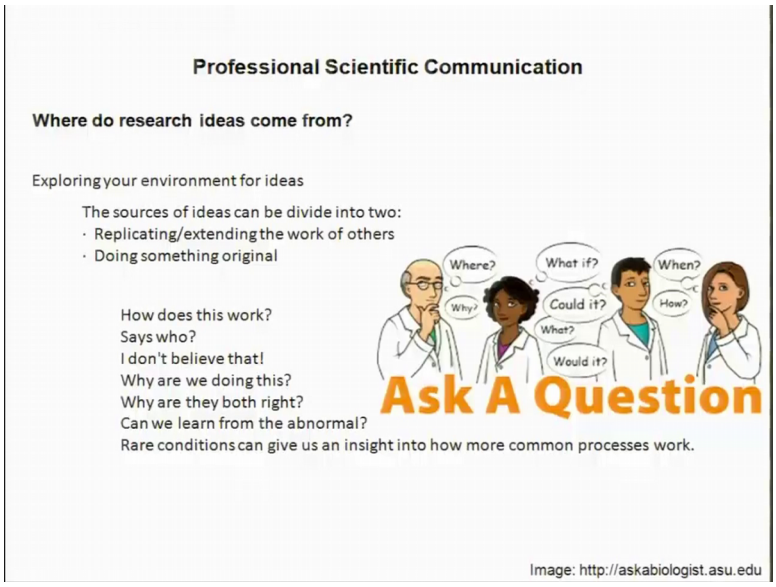

So, it is important to discuss with people. So, that is important that you need to ask questions that is extremely important in science you should ask; why? You should ask where? We should; what if, why not and so on; ask questions do not just go by what people say.

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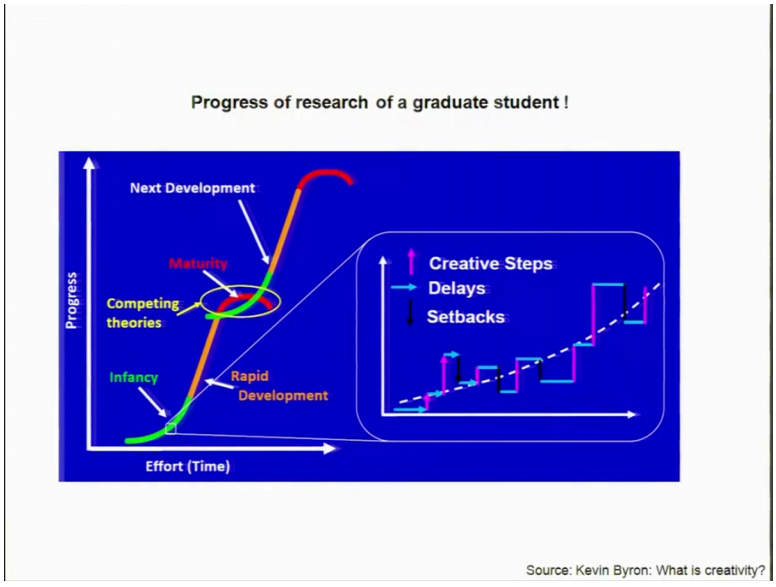

So, if you look into the research career for example, of a PhD student; this is something shown on this screen here. This is something that I borrowed from the slides of Kevin Byron; he is a very famous Physicist in London, who was done phenomenon work not only in his chosen field, but about for example, how to do research, how to innovate things? I mean you should go and read about him and read about all his writing, it is absolutely phenomenon; you know some of the ideas that I am going to discuss here today are all borrowed from his; literature, papers, monograph that he has presented.

So, this is what he says which anybody who has went to through this process who would know for sure is indeed the reality. So, when you start your work; it is called as infancy, you have started your research career as a PhD student or for a master thesis and you have certain ideas that what is shown here in the green; in the lower bottom of left side the graph, green one what is called as infancy; is the germination of the ideas; you have discussed, you have read that you have certain ideas.

Then what you have is then you have the idea and you ask questions and then you have to answer these questions with certain approach that is where you do experiments. So, if you have very good hypothesis and questions and you have found appropriate tools to answer this questions, then you would get observations and that is what called as rapid development. So, a varying data right it could be anything right or depending on what kind of approach you have taken.

So, you will be getting, but the tools and approach that you have used can take you only to certain distance. Soon you will find that you cannot go beyond that meaning that you are able to address few you know questions, but still by them; you know with the observations, now you have too many more questions which your data cannot address. So, that is what called as completing theories; by now you have observations, then you are interpreting the observations and you are getting there this could be like, this could be like this, you have multiple theories, hypothesis coming out.

So, then it slows down; research slows down; so, what you need to do? So, you have one or two, three hypothesis for each one of it now, we have to have you approaches to answer, we have to prioritize this is my first, this is second, this is third and then again do experiments and then you will get data, which takes you to the next level.

So, it is a repetitive process as shown on the right on the screen; we have creative steps which help you to develop tools to address some of your questions, observation that you know help you to support your hypothesis one way or the other and then you generate knowledge. Once that is done then there is a delay because now for the next step again you need to ask you know evolve another set of hypothesis the questions, there are alternate possibilities; test each one of them and see which is correct and then again it takes you.

So, if you see that always there is a creative step and there is a delay because then you have to assimilate, understand and then divides new tools and approaches. And there are setbacks for example, you may have three different hypothesis which may be compelling, which may be attractive, but may not be accurate. A given hypothesis when you test; it flops, your results do not come the way it is expected and I will talk about hypothesis little later; then why say result what you are going back to square 1; you have to come up with an alternate possibility again divides experiments do result and then you see whether it is; so it there is a delay, so that is how.

But with time, we progress right and that results in a scientific, communication, paper or thesis or degree whatever right or a product. So, that is how science work; that is creative step, there is a delay and they set back; so setback is very very common to research programs, so it is nothing unexpected. So, if you are facing challenges in your research do not feel bad because that is expected that you would face setback; because only then you open some other door that you never thought of would before then you will find a way right.

So, that is essential and that is what being discussed in this particular chart. Let us see so how to be successful as a researcher you have to be creative, it simply cannot follow the crowd.

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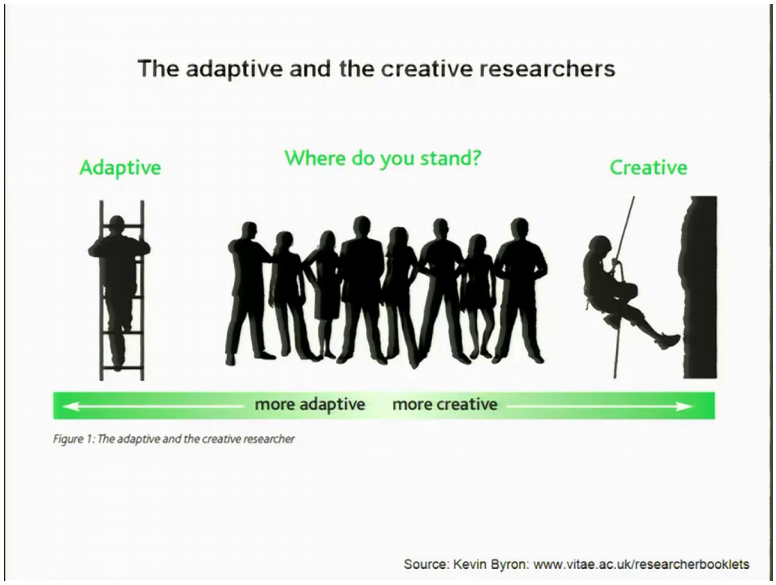

Figure 1: The adaptive and the creative researcher

What is shown here is that there are some people who are more adaptive, some people that are creative, some people stay that is here right. Adaptive or those people you find that there are tools available use that and you get certain observations. But then you are good as good as the tool right if you do not have any tool; then you are not going to do because tools it is not something that you are going to create; therefore, you have to be creative.

Creative is somebody who does not really look for any laid out path or a place somebody had gone before; you have to go to a place where nobody has gone before, that is what called is creative. So, you have to develop tools, new ways of reaching your target that is shown on the right side. For example, put a rope, climb up go there is nothing like laid out path it is tough, but it is challenging, but you can reach heights that no one else has reached. So, we have to be creative; if you want to be successful researcher. So, this is you know important it is not just doing experiment, but you have to come up with novel ways of doing experiments, novel ways of you know developing methods and that itself is a challenge something that you need to think about and therefore, we can go to places that nobody else gone before.

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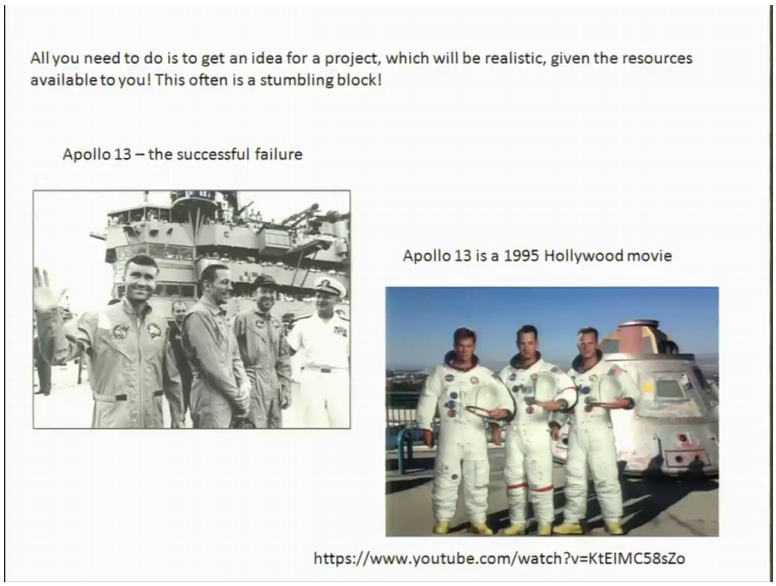

I have given an example that failures are part of very good discoveries and invention so on. I will give one example that is called as successful failure; so what is shown in the screen is that a snap of the Astronaut; who have come back from the mission to the moon without succeeding that is called as Apollo 13 mission. And I am giving this example because to get an idea for a project which will be realistic; you need to know what resources that you have and whether you could address that particular question with the resource you have.

You have a good question, but you also thought about approach, but you do not have any tools with you, you do not have any resource with you; it is not going to help. So, you can do things only with what you have; so that is called as being realistic.

This Apollo 13 although it is called as failure; because they could not because this mission was to land people on moon and they could not do that, they came back and still it is called as successful failure because they were able to do something unthinkable to bring back these people who are at the mission. For this you need to go watch this movie; Apollo 13; it is 1995 Hollywood movie and it is freely available; those people who watch the YouTube, you can go and watch this; is an excellent movie.

So, basically these are the three astronauts that are shown the real astronauts on the left side; acted by people that are shown on the right side. They really wanted to go to the moon and they were the space mission somewhere when they were approaching the

moon, their spacecraft developed some snap and they had to really now find way; not to land on moon, but to get back to the earth because it is going to be challenging for them to comeback.

So, the mission now; the whole mantit of the mission has changed not for landing on moon, but to get back to fix the problem that the spacecraft has developed and to bring these people back to the earth. And this cannot be done by people who are sitting in the mission control room; who are in our planet, but by people who are in the spacecraft; the astronauts not only that they have to do with whatever little that they have in the spacecraft to bring them back.

Therefore, you have to innovate; you have to do things very different by having only those few things that you have at your disposal and you can do that if you have the limitations, so you need to know the boundary. So, these are the thing that I have; this is the question I ask can, I do this? The answer is if you know what you have and if you can do that; that is best, you cannot really think of something that you do not have and say that well; I could not do, that does not help.

So, you need to see what you have and how that could be addressed that is where; that movie really helps you to understand and why it is called as successful failure because they could not land on moon, but yet they could comeback therefore, it is successful failure. I will give you some other example as to how sometimes; a simple observation, simple approach can make great impact in science.

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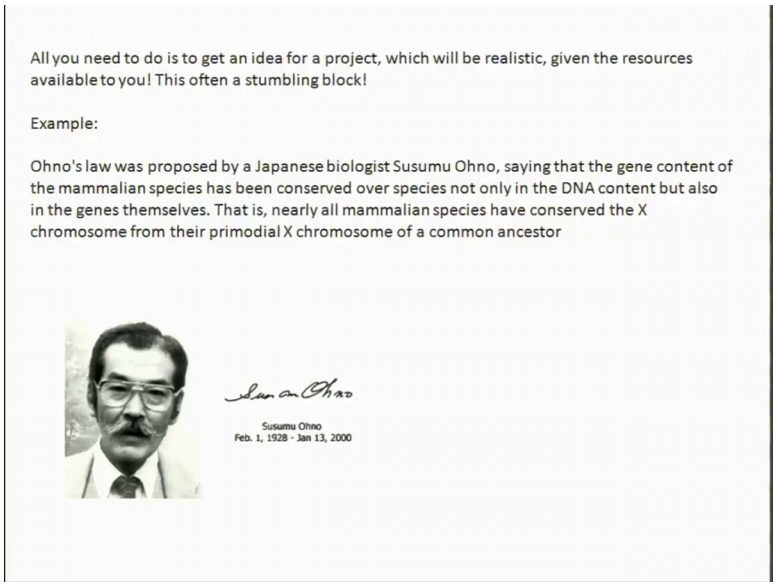

This is about a famous scientist called Susumu Ohno, sort of put the hypothesis and he tested the hypothesis to some XTS proven that the mammals; all these species that we are one among them they called mammals have pretty much the same amount of DNA per cell. And that the X chromosome; one of the chromosome that we have in our cell is about 6 percent of the total DNA.

This is something he said even before we know how much DNA per cell we do have. So, this was done in 60's when nothing was known about, but he used very very simple approach and this is called as Ohno's law because now you know that it is absolute what he said this correct, accurate therefore, this called law.

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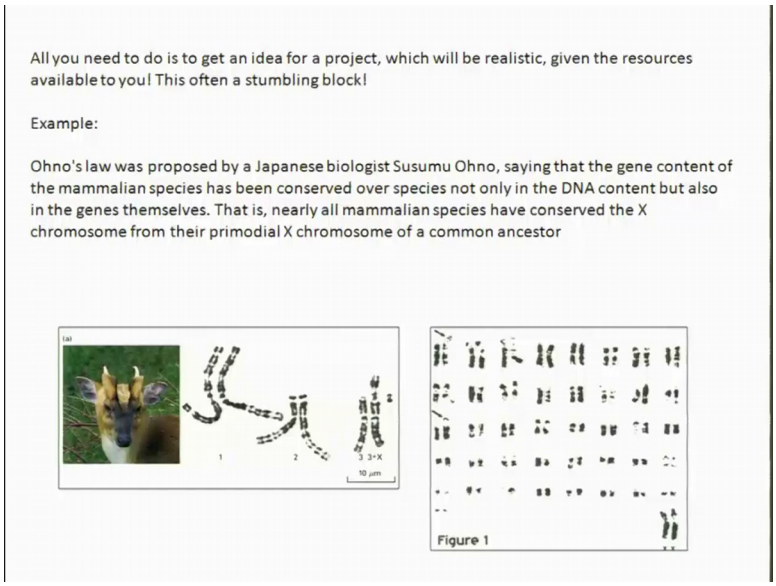

So, how did you do that? And if you look into the mammalian species, there are species that have only 6 chromosomes like the one that is shown on the left side; it is one of the deer family animal which is got only 6 chromosomes. And there are animals that have got a large number of chromosome having up to 60 pairs, 70 pairs, 80 pairs and so on.

But what he did was remarkable; so he made this kind of what is called as chromosome preparations and took a photograph and then printed them in the same magnification using the printing papers, people used to do that kind of printing earlier. And then he cut each chromosome with seizers and you wait; you find the regardless any species that he looked at for the chromosome preparation, regardless of the number of chromosome; the weight of the chromosome cut out were identical and this X chromosome was about 6 percent of the total weight.

Therefore, he said that the DNA content per cell in all the mammalian species is constant and sex chromosome is conserved meaning, the genes that are there X chromosome are identical possibly in all the mammalian and species and that constitute 6 percent of it. It is a remarkable discovery, now we know with advanced techniques where now we have sequence the genome and each chromosome sequences known, number of genes known, the length of the DNA known.

Now you know that what he said is accurate therefore, we say it is Ohno's law because that is something that we can prove now which he has proven you know 60 years back

with simple approach; just photography, cutting the chromosome weighing using a balance that is the physical balance that you must have seen in chemistry labs.

So, that is what science is you have to have observations; you have to have good questions and then look at too that you have; which can address and then you can come with you know discoveries that are time tested and now you call as law; so it is doable right. So, why some are successful? Because they are able to ask questions.

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This is what something that is put on the screen again they borrowed from Kevin; that is I have six honest serving men, they taught me all I knew; that is what he confess; I call them what and where and when and how and why and who; because these are the question that you ask to address any problem and then able to come up with something novel discovery and so on.

So, if you look into the questions; the question that you ask is fundamental to research it is called as enquiry wheel again I am borrowing it from Kevin.

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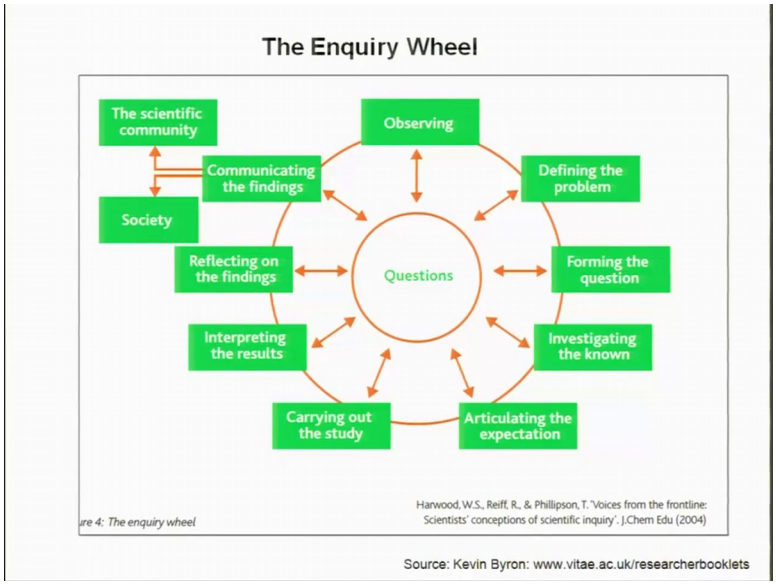

This questions really ask like; you ask something and then you start observing that is called as observing. Once you observe again you ask certain questions that these are patterns that are similar; these are pattern that are similar and then you define a problem, when these patterns exist like this probably they mean this.

And then you ask again question; is it that you have a pattern that the animal behave in a different way; that is a question you ask and then you test them and then that when you test you know that what question you asked is accurate, then you say that yes that is what happening. And then you go on addressing each one of it and finally, discoveries are made, you communicate others get to know.

And this is called as the enquiry wheel; all great scientist that you talk about whether is a Darwin, Mendel all these people have asked these questions; that is why even after centuries of their discoveries; we still talk about. For example, you call Mendelian laws; we call them laws because every gene that you talk about that form; that kind of segregation obey; whatever Mendel expected; that is why it is called the law.

But these were observations, these were theories, these were hypothesis, but many many many scientists have repeated these experiments and you can predict that this what would happen and it would happen; that is why it is called as law. Therefore, asking question is an important integral part of science and you need to question at every stage you need to question; without question you will not get an answer. When I say question;

it is not that you go and question somebody else. You have to ask questions to yourself, to your own scientific problem and then final answer for this; it is you by reading, by thinking, by discussing; it is not that somebody is going to come and give you solution that does not happen.

Therefore you need to ask questions; so let us revisit the six honor serving men; who could help me in finding ideas, from where do you get idea? Why, what, where, when, how and so, on. So, you will see everywhere for example, there are campus like you go to your university, you are go to institute is spread out there are so many buildings, you want to meet a particular faculty in a particular department; what you do? You need to ask if there is a security person, there is a guard or somebody you go and ask; this is the department I wish to go, this is the lab I wish to go, this is the building I wish to go; where it is? What if nobody there; how will you find? It becomes challenging.

Therefore there are sign boards like what is shown on the left side, it says you have to go this way for example, you going to a park then it all says that; it is easy then you do not need to ask anybody. But at times, you may have campuses which have roads, which have buildings nothing is named; no sign it then you have to go and ask somebody there, as to where it is?

Now whether he would help you depends on whether he knows where that particular building exist, where the particular department exist or his information may not be accurate; he would say you go on the right side, turn left there is a tall building that is where the building; the department is you may go where you will find out; it is not building right therefore, you know it becomes challenging.

So, you can simply ask a question how can I change this environment? Can I make for example, very good sign boards, if I were to do that; what would I do, how will I do, what are the things that I need, what information I need, who should I contact, how do I make effective sign in boards? It is simple example for you to workout in your own college, in your own institute, in your own university, in your own township; how possibly you can make a difference; this is what ideas right you can make the difference; that is what it is; define the problem.

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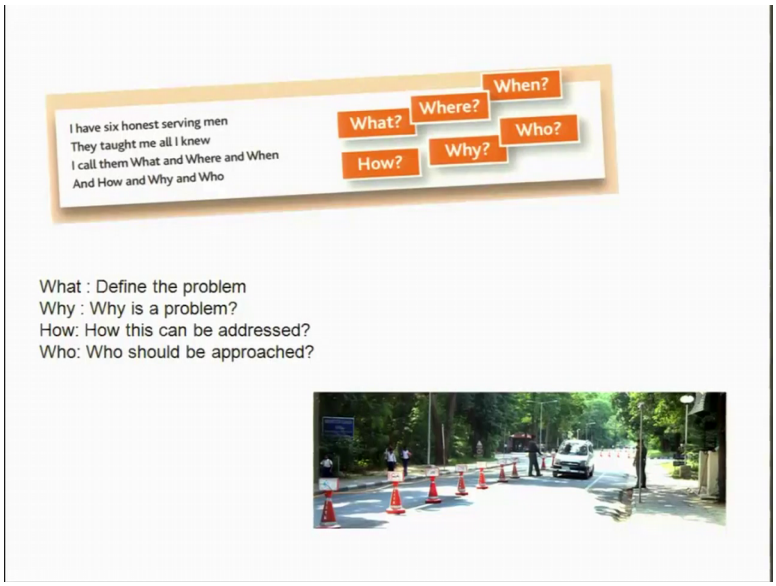

The problem is; you do not have signage's or there is a problem because you do not have very good way of communicating or it could be; there are people from; speak different language they come here. So, you putting one language may not help; so you want to help something very different than what others thought about, the need could be different.

Therefore you need to define the problem and then you have to ask question as to how to address the problem and then who should be approached, if you want to implement.

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So, in all these you ask questions and it is everyday our part of life that you go to railway stand or bus stop, then you will find that bicycle parked like this. You left your bicycle in the morning, you comeback you want to locate your will bicycle; it is going to be exceedingly difficult to pull out your bicycle. Say can there be effective way when in the crowd of hundreds of bicycles that are there; how can I you know locate anyone's bicycle; is there a way I can improve the system?

Or for example, junction; a road where four different roads meet together in any of the Indian cities; it is a chaos, you do not really find a way; can this we addressed? Most of the developed societies have addressed these problem and they do follow. But may be that is not practical here or maybe we do not follow, but you can ask questions; how this can be answered whether you are able to do it or not is different.

But asking questions, finding a solution will improve your curiosity and you are ability to come with certain solution, which who never knows one day you may become the Mayor of that town or you will become an administrative officer or you could become a politician, who could possibly fix this issues. So, you have to think about it and ask questions and think about solutions which would help you to become a better scientist; so that is what it is. So, you have to look for ideas; these are either that are already that are done the literature you read and then you find what is not present, what is a black hole, what is the point that is not discussed and then do experiment to add on to the existing already or do something altogether original and then you know all for all these things you need to ask questions.

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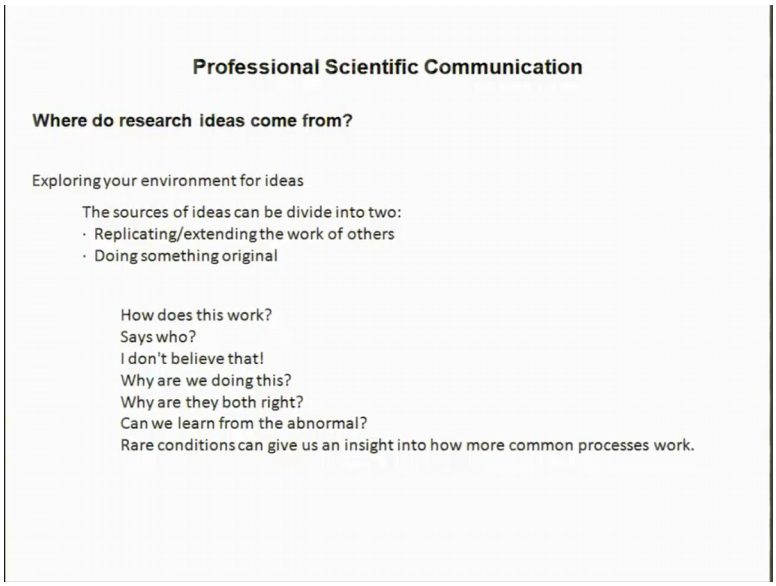

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So, I will leave you with certain contemporary topics for you to discuss, think about and ask questions and approaches. One is for example, often that is there in the news now is Delhi pollution, the pollution lover; this is the most highly polluted city in the world. And then there are doctors who say that well get out of this city, this is not good for your health; you may have all problems; so, that is what it is.

So, now the question is that why Delhi is having very high level of pollution as compared to other city; is it the problem that has a source in Delhi itself or something

else; this is one question that you may want to address. Because without knowing the genesis as to why you have pollution; you cannot solve it. So, once you know why do you have pollution? Then you have to come up with ways to mitigate, to control, to reduce.

So, you need to ask questions, you need to go and investigate; most of these can be done by doing literature survey that is what I want you to do go and read and you will be able to find, but you have to ask question even if you want to go and search it in the Google then you can get an answer only if you are able to type a question. So, therefore, the questioning anything is important even to get an answer for a question that is already there you need to phrase the question and you can get it.

So, you practice using Google search or Yahoo search, but you need to have questions. So, when you ask question probably you will get an answer; then you can make a small report that would help may be as a school project or as our college project and so on, but you need to know first what is a source of pollution, why Delhi, what is unique about it, how are you going to mitigate, how long it will take? When you know these are the elements that you get answer only if you ask relevant questions.

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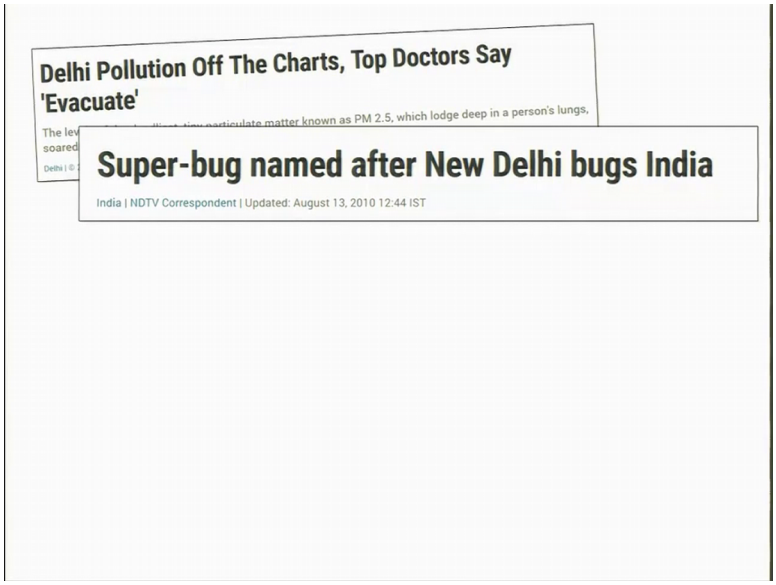

There could be other for example, you know some time back there was lot of buzz about the super bug named after New Delhi because somebody who came to Delhi had this particular bug therefore, they said that the bug exist in India. And there were lot of

research which you know papers and so on which said probably is not something new or not form Delhi on things like that. So, you want to ask the question because you do not want to have your national capital named after a bug which is not so good. If it is named after something which is good, it sort of gives a positive image.

So, you want to see whether really is it form here; so you investigate again you may get very good answers for that.

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Now again go for even contemporary problem; so there are news paper, reports say that the demonetizations happened about one year from today; lead to job loss for example, you know it really killed the small scale industries and people who run small shops and so on which may be right, which may be wrong, but how will you say that it is correct or it did not affect, did not affect you have to go and analyze; how do you do that?

There are ways to do, there are growth indicators; you have to go and survey people; look at the profit ratio and then come up with a report which suggest; yes it did affect or did not affect because you cannot just follow something what people said because there could be sampling error. They would have taken only for example, one particular city which has got so many travelers, tourist and they were dependent on the tourist when demonetization took place for example, only those industries that were dependent on tourist you know were affected.

But if you go to something else you know with sales for example, day to day bread and milk and so on; now I have money now in there is a demonetization I am going to not going to spend on the visiting my you know relatives, but I would spend my money in buying essential need. Therefore, this particular market right or shop may not be affected. So, therefore, we cannot make a sweeping statement; so, you all ask questions and methods to validate and go and find yourself whether it really had an impact.

Another biology centric problem, I can suggest is that for example, all of you must have known about this determinant Michael Phelps.

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He is one who was record for winning the maximum number of gold medals in Olympics; he is swimmer from Australia. This guy; he is phenomenon if you look into the records; you may want to go and check and one of the suggestions or hypothesis was that this guy has got the lung surface was so huge, then many other swimmers this guy is able to inhale the large volume of air; therefore, he could get more oxygen than most of the people; therefore, he is able to power himself better as compared to other swimmers.

This may be just a kind of a notion that may not survive the scientific scrutiny or it could be any just a coincidence that he has got a larger lung surface; but really that alone did not make him a different. So, how will you test it? So, you have to ask questions is it that every swimmer who is successful; he is able to get you know win the gold medal in Olympic has got large lung size.

In other words, is it that anyone who was got large lung surface; excel well in athletics; these are the questions that you need to ask when you ask then you will find an answer which really really; come up with certain discoveries that could be become a kind of in future what is called as law. So, these are the ideas that is something that you will need to look and then you can take up and then go and sort of (Refer Time: 32:51) and that is where I leave today for in this lecture, that you have to look at your surroundings, your environment, ask questions.

And then go and you know you when you ask questions we can seek answer; you yourself go and read about it, build and write a small report on for example, the Delhi air pollution or on the super bug or on Michael Phelps or on demonetization. You can go on do a survey and you can with your own small town, you can come with certain conclusion as to really it had an effect and so, on.

So, that is how you sort of develop first your curiosity; curiosity to observe, curiosity to ask question, curiosity to develop an hypothesis, curiosity to test the hypothesis and come up with conclusion. So, you have to keep your eyes open; you have to look at patterns, you have to sort of think about it yourself and ask questions and find answers; which eventually would make you a successful researcher; years to come.

So, with that we will end this particular lecture and we will meet again for the next lecture; where I going to introduce to you what is called as hypothesis building; see you again.