Science Communication, Research Productivity and Data Analytics using Open Source Software

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Lecture 1: Introduction to Science Communication

Dear Learners, Welcome to the first week of this 12-week course on Science Communication, Research Productivity and Data Analytics Using Open-Source Software. The lectures this week are divided into two parts. So, the first part is focused on the basics of science communication, why scientists need to communicate, what are the different avenues available to communicate the science, and the key attributes associated with them. In the second part I will be discussing Open Science. So, after completion of this week you will have an understanding of what science communication is, what are the channels and their structures. You will be able to distinguish between different channels of science communication. So, this is a foundational block that will help you in correct assessment of the research productivity. So, let's start the first lecture of the first part of this week.

So, science communication comprises two distinct but interconnected concepts that is first is science, and then second is communication. In simpler words science is defined as the pursuit of knowledge whereas communication is the art of sharing the message. So, we will first briefly see what exactly each concept is and then we will move to the whole concept of science communication.

So, let us first see what communication is. So, the word communication originated from the Latin word ‘communicare’, which means to transmit or to share. Communication is just a process of transferring information from one individual to another. So, let us understand this whole communication process through this illustration. So, let us assume that on the left-hand side this is Person A and on the right-hand side there is Person B. Now Person A wants to share the message about the tree with Person B. So, Person A wants to share the message about the tree with Person B. So, firstly Person A encodes and frames this message about the tree and uses the appropriate channels. Say for example, in this case let us assume that Person A uses the verbal channel. So, using the same channel it transfers the encoded message of that tree to Person B. So, Person A transfers this encoded message to Person B through a verbal channel. So, as soon as Person B receives the message, if Person B perfectly decodes this message about the tree, then it is said to

be a successful communication. But if in any case this encoded message about the tree does not reach Person B or Person B receives the partial or distorted due to various reasons of noises, then it will be said that successful communication does not occur between both the person. So, this is just the basic idea behind the concept of communication.

Let us move to another concept of science. So, what science is? So, the word science originated from the Latin word 'Scientia', which means knowledge. So, if we define science, it is the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence. So, if we see this definition, this definition has three key parts. So, the first part is the pursuit and application of knowledge.

So, this is the first part which means accumulation of knowledge. So, knowledge is accumulated. The second important part is knowledge of what? So, this is about the world we are living in. So, this is the second part. Now the third part is which knowledge? The knowledge which is created using a systematic methodology having the evidence. So, these are the three key parts of science. This is why throughout this course when we refer to science it does not only mean physics, chemistry or biology but it also includes applied sciences, social sciences, and humanities. So, science has been the driving force in the progress of humans. The advancement in science has significantly enhanced the quality of human life.

Take the example of medical imaging. X-ray, ultrasound, and CT scan are helpful for diagnosis and treatment of diseases. Another example is GPS, the global positioning system. From ordering food to booking a taxi online, we use this global positioning system and it helps in improving communication, navigation and weather forecasting impacting various aspects of our daily life.

Now take another example: refrigeration. Refrigeration is another application of science which enhances the storage system. Now food can be stored for a longer time. So, the application of science is everywhere from finances to behavioral studies to group dynamics to policy and welfare schemes. All this scientific research helped humans lead better lives. So, recently we have seen the COVID-19 pandemic, and from testing to vaccination all this could be possible due to the advancement in science.

So, this list of examples and applications of science are long, and where you will find various applications that had an incredible impact. So, as we have discussed above one has to follow the systematic methodology. So, this is the important part that one has to follow the systematic methodology for the creation of knowledge. So, this systematic methodology is known as the scientific process that is followed for generating new knowledge. So, let us now see what this scientific process is.

This is just the whole scientific process. So, these are the six key steps in the scientific process, and we will discuss each of the steps. So, the first step in scientific discovery starts with the observation of the phenomena. All facts related to those events are carefully observed and collected. This step is a foundational step for the whole scientific process.

So, once scientific observation has been done the scientist formulate questions and make assumptions and testable hypotheses that guide the research for further steps. So, this is the second step. So, in the first step we observe the phenomena. So, we collect all the facts related to that phenomena and in the second step based on those observations we formulate the research question and hypothesis. So, in the third step with the research question and hypothesis the scientist plans the whole experiment.

How to do the experiment like what all will be the variable, the tool to be used and all those things. So, once the whole planning is done in the fourth step the scientist starts the experiment. Scientists start the experiment with collecting the data, data pre-processing, data analysis, testing the hypothesis, and carefully observing the findings of each research question. Then in the process we move to the next step. In the fifth step, based on the experiment scientists draw a conclusion and note down all the research results. After detailing the results, theories are formulated. In the last step scientists share all these findings and the whole knowledge about the phenomena with the outside world.

So, this is the sixth and final step. So, if you see in this whole scientific process, it comprises two sub processes. So, the first sub process is these five steps. So, this is the first sub process, and this is the second sub process. The first sub process is from step one from observation to the results to step five.

So, the last step is the communication of the results. So, these communications of final results are considered as the essential parameter for evaluation of scientific productivity. So, this course is all about the second sub process of communicating the scientific results. And we will be discussing only this part in this 12-week course: how results are communicated, what are the different channels, and how publication of these results is considered for the evaluation of scientific productivity. So, what is this last six step? We will first focus on these six steps in detail then we will go ahead to understanding the different channels of communicating the results.

So, we have seen in the last slide that the scientific process for creating the new knowledge is a regression and it requires huge effort and infrastructure. And after this much investment if this new knowledge is not shared or used for solving the problems then there is no use of that knowledge. So, let us understand this with the illustration. So, on the left-hand side assume this is a scientist A or maybe there are like a group of people

on this left-hand side. On the right-hand side this is a B group, maybe like this is the external world.

So, now this group has discovered some implication of this particular tree X which can be useful for treatment of say for example disease Y. Scientist A does not communicate this to anyone to the outside world. So, the outside world will remain unaware about this knowledge so the whole society will not be able to take advantage of what group A has identified the possible implication of the tree X. So, take another example like if the physical nature of different waves had not been shared with the outside world how would medical imaging have been possible. So, this is why science communication is essential not only for the benefit of society, but also for the advancement in science.

We will see all those reasons for communicating the science in this lecture only. Let us first define what science communication is. So, science communication is the process of dissemination of knowledge generated using scientific methods to experts and lay people in an easily accessible way. So, if we see this statement, it has four key parts: purpose, what, whom, how. Let us see each part in the statement.

So, the first step is the purpose of the science communication which is dissemination of knowledge. So, now we know the purpose then the second part is which knowledge. So, the knowledge generated using the scientific method. So, this is the second part of this definition. Then okay now we know the purpose of science communication also we know the kind of knowledge to be shared, which is generated using scientific methods.

Now the third part is to whom to be shared. So, this is the third part that should be conveyed to experts and the lay people. Here experts we mean the scientific community or the subject peers, and the lay people represent the general public.

And the last and the most important part is how to do that. So, it should be done in an easy and accessible way so that concerned people can get to know about the discovery. So, this is the fourth part. So, now let us see let us understand the different components associated in science communication with another example.

So, in science communication these are the three key components. So, this is the first component which is known as the messenger of science and it includes two groups. The first group is the scientist. So, let us assume this is the first group. So, this is a scientists' group. And then there is a so this is the first group of scientists and their team who exactly send the message.

Then the second group is an outside world which includes experts and other people they receive the message. So, let us say for example the outside world. So, this is group one, and this is group two. And the second component is knowledge which scientists create in

the lab following a scientific process. So, the second component is the knowledge which scientists create in the lab following a scientific process.

And the third component is channel. It represents the various mediums and the scientific community uses for communicating the findings. It includes from traditional print and broadcast media to digital platforms and social media. So, the first group who sends the message generally follows an anti-clockwise approach. So, they first create the knowledge and then select the appropriate channel to disseminate the knowledge. However, the second group, which is the outside world, follows a clockwise approach to access the knowledge.

So, they first select the channel to know about the scientific discovery and then they access the knowledge. So, let us now understand the motivation behind the science communication by the Wobble analogy formulated by Burns and other two authors in 2003. So, they defined science communication as using skills, media activities and dialogues to produce one or personal responses to the science. And these responses are awareness of science and enjoyment or other effective response to science, interest in science, opinions and understanding of science. So, the first is the awareness of science, enlightening people on different aspects of science to motivate people to attain scientific literacy.

This could be done by conducting science related events, highlighting scientific achievement and emphasizing the role of science in everyday life. Then the second response is enjoyment. You know enjoyment is generally considered as the key motivator for doing things continuously. So, it is about the feeling of satisfaction in the discovery of new findings to the problem and sharing with the community. So, the third response is interest where the person has voluntary or non-voluntary interest in science.

And the fourth is the opinion. So, effective science communication helps to address misconceptions and misinformation and build trust in science. So, to take the informed scientific opinion, science communication is to be done. And the last response is understanding. You know the knowledge is huge and continuously evolving. So, one has to go step by step to understand the application of knowledge.

So, science is communicated to understand the science. So, these are the five responses which were formulated by this author in 2003. So, these are awareness of science, enjoyment, interest in science, opinions, and understanding of science.

Now questions come why we need to communicate science. So, there are various reasons for that. Some of the reasons why science is to be communicated are presented in this slide. So, we will see each of the reasons one by one. So, the first and the foremost reason for communicating science is to share the findings of new discovery and what all are its implications. The second is that science is dynamic in nature, and no knowledge is static.

So, it is continuously evolving. So, it helps in connecting the dots of previous research to look for the advanced solution. So, the third is to receive the expert opinion and validation of the findings by the peer which enhance the reliability of the scientific work. So, say for example somebody has formulated some theory based on their results. It should be tested by some other examples and it should be tested by the experts. So, this is why peer feedback and validation are required so that the authentic knowledge is disseminated.

Then it supports the development of new technology products and services that solve the problems and help in this effective decision making. So, another reason for communicating science is to engage the public in scientific activities and enhance scientific literacy and temperament that will help in making informed decisions and mainly combating the fake news, the misinformation and all. So, that can be tackled if science is communicated in a better way. So, another reason for communicating science is to inspire and motivate future generations in excitement and relevance of scientific exploration so that this process of new advancement and exploration of science can continue. So, to motivate the future generation to engage in exploring the new findings through their research.

And the last possible reason is to receive appreciation for the scientific discovery made so that good research can be rewarded. So, there can be other reasons for that, but these are some of the key reasons why we need to communicate science. So, for effective science communication, every scientist needs to prepare answers to these six questions. So, these are what, why, when, who, how, and where. So, the very first question is what gives the understanding of what needs to be shared, what part of your finding to be shared, whether you want to share the whole findings or the part of that findings.

Then the second question is why, why is it important to know about your findings, why is it important for the community, why it is important for the community to know about your research. So, whatever you are planning to share why it's important for the outside world to know this finding. Then the third is when to share this knowledge, when exactly you want to share this knowledge either you are in between the research or after the research or you want to see more implication and you want to see more testing on that. So, it gives the understanding that when you want to share those results to the outside world.

Then the fourth question is who should share this knowledge. So, it gives the idea of a target audience. So, who are the people who will be benefited with this knowledge, what you have created. And the fifth question is how, how this knowledge will be shared, which channel is to be selected for sharing the knowledge either written verbal or anything else. And the last question is where, so where knowledge will be shared. So, if a written channel is selected whether it will be a journal, book or a social media post.

So, this is how answering these six questions helps in communicating science in a better way. So, various channels are available for the scientific community to disseminate the science. Some of the popular channels are listed here like journals, conferences, symposiums, seminars, books, theses and dissertations, patents, lectures, reports, and policy documents. So, and in recent times with the emergence of the internet and the worldwide web, other outlets like different websites, blogs, social media platforms, like Twitter, LinkedIn have been popular among the scientific community to disseminate their research. So, earlier there were no metrics or data sources available to capture this online attention of research dissemination on the channel.

But some metrics like altmetrics have also emerged in recent times that track down these sources. So, we will be discussing more about altmetrics in the upcoming weeks. So, however, most of the science is communicated through publishing in these channels only. So, these are the channels which are preferred by most of the scientific community to share their research findings. And one of the reasons is that these channels are also mainly considered by many of the organizations and ranking agencies for evaluation of scientific productivity for recruitment, promotion, and granting the funds and all.

Okay, so I will stop here and I hope you have enjoyed this lecture. Please let us know what your motivation is to communicate the science. Post your answer in the discussion forum. In the next lecture I will discuss the different channels and the key attributes of each of the channels. Thank you.