INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

NPTEL

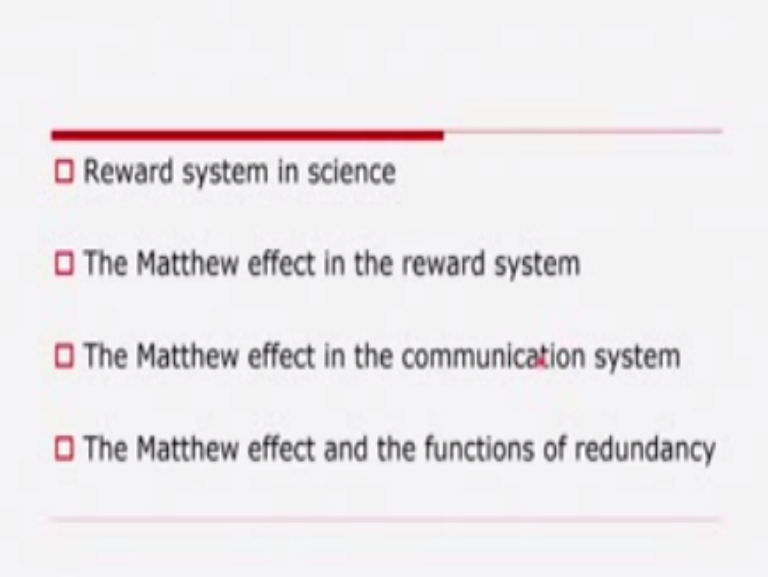
NPTEL ONLINE CERTIFICATION COURSE
An initiative of MHRD

Science, Technology and Society

By
Dr. Sambit Mallick
Department of Humanities and Social Sciences
Indian Institute of Technology, Guwahati

When we discuss the Mathew effect in the communication system what I mean we have discussed reward system in science, the Mathew effect in the reward system, the Mathew effect in the communication system now we are going to end okay, I mean there is reason to assume that the communication function of the Mathew effect is increasing okay, is increasing in frequency and intensity with the exponential increase in the volume of scientific publications.

(Refer Slide Time: 01:09)



Which makes it increasingly difficult for scientists to keep up with work in their field in their respective fields okay. Perhaps no problem facing the individual scientist today is more defeating than the effort to cope with the flood of published scientific research even within one narrows facility. Studying of the communication behavior of scientists like that within the purview of the

Mathew effect in the communication system okay, it shows it has shown that confronted with the growing task of identifying significant work published in their field scientists search for queues okay, to what they should attend to one such queue is the professional reputation of the authors.

The problem of locating the pertinent research literature and the problem of authors wanting their work to be noticed and used as symmetrical that is the vastly increased bulk of publication stifling the competition between the papers for such I mean I mean stiffens the competition for competition between papers such notice, the American Psychological Association almost 50 years back okay, found that from 15 to 23% of the psychologists readers behaviors in selecting articles were based on the identity of the author's.

The workings of the, that is what Robert Martin pointed out the workings of the Mathew effect in the communication system required us to draw out and emphasize such an implications about the character of science and its associated scientific practice, and a reminder that science is not composed of a series of private experiences of discovery by many scientists as sometimes seems to be assumed in enquiries centered exclusively on the psychological processes involved in discovery, okay.

Then science is public science is not private okay, it is true that the making of a discovery is a complex personal experience and since the making of the discovery necessarily precedes it fate according to Martin the nature of the experience is the same whether the discovery I mean whether the discovery temporarily fails to become part of the social he said culture of science or quickly becomes a functionally significant part of that culture, that is why from the very beginning I said Martin know the functionalist within the paradigm of sociology and social anthropology and he is functionalities, his functionalist orientation has delved into the such examination of science and the kind of inequalities that science is always in doubt it okay.

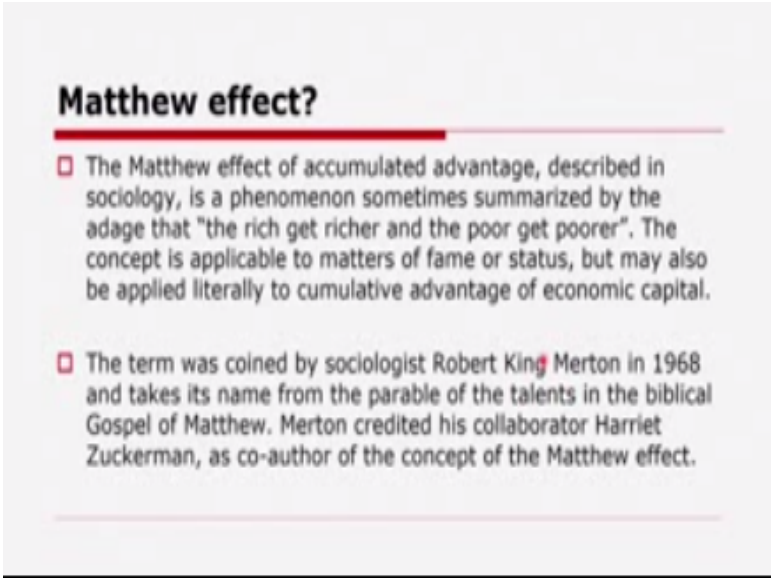
But for science to be advanced it is not enough that fruitful idea is the originated or new experiments developed or new problems formulated or new methods instituted, the innovation must be effectively communicated to others that after all is what we mean by a contribution to science, a contribution to science within good okay. Something that is given to the common fund of knowledge common base of knowledge okay, in the end what we get, in the end then science is a socially fed and socially validated body of knowledge okay, for the development of science only work that is effectively perceived and utilized by other scientists then at their matters.

In investigating the processes that shape the development of science it is therefore important to consider the social mechanisms that Coerver facilitate the incorporation of would be contributions into the domain of scene. Looking at the metal effect from this perspective from the perspective of the communication system okay, what we have discussed okay, that the I mean the distinct possibility that contributions made by scientists of considerable standing are the most likely not to enter promptly and widely okay, into the communication networks of science and so to accelerate it develop okay.

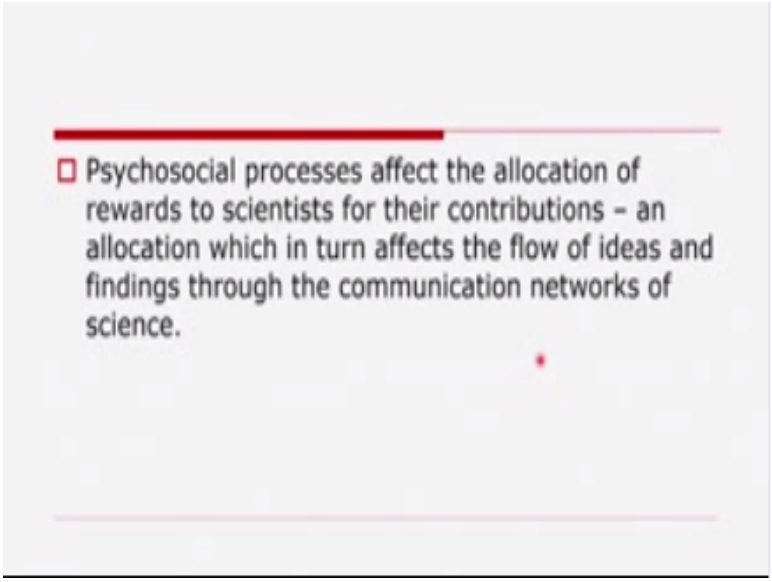
Then what we have discussed till now if you look at we have discussed Mathew effect in science how the reward and communication systems of science are considered okay.

(Refer Slide Time: 06:47)

(Refer Slide Time: 06:48)

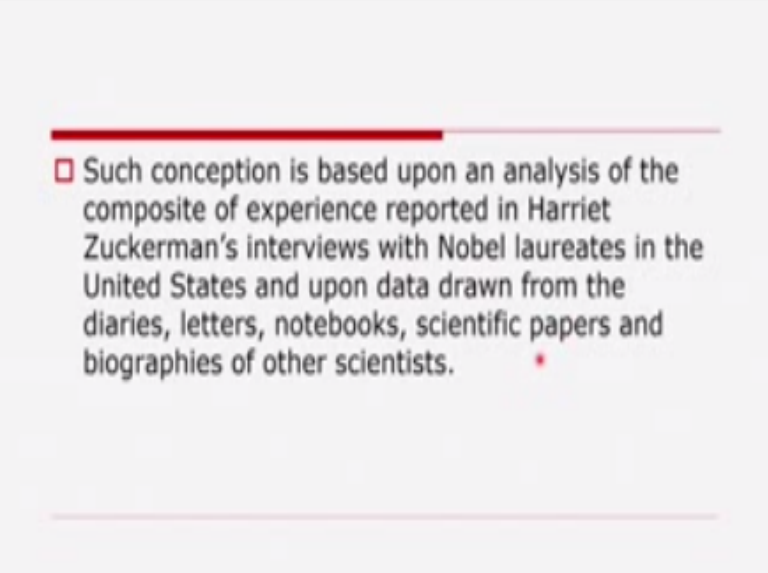


(Refer Slide Time: 06:52)



The Mathew effect in science, the Mathew effect in the world of science how Martin tried to deviate the psychosocial processes which affect the allocation of rewards to scientists for their contributions that is an allocation which in turn affects the flow of ideas and findings through the communication networks of science okay.

(Refer Slide Time: 07:13)



And such conception is based on upon an analysis of the composite of experience reported in Harriet Zuckerman's interviews with Nobel laureates in the United States and upon data drawn from the diaries, letters, notebooks, scientific papers and biographies of other scientists Harriet Zuckerman was collaborator of Robert Martin and his second wife and then we have discussed within Mathew effect in science that the reward system in science the Mathew effect in the reward system and the Mathew fact in the communication system.

In the letters to follow what we are going to discuss that the Mathew effects and the functions of redundancy, social and psychological basis of the Mathew effect and the Mathew effect and allocation of scientific resources okay. In this context we are going to discuss now the Mathew effect and the functions of redundancy, constructed in this way constructed the way we have discussed the Mathew effect in the reward system as well as the Mathew effects in the communication system okay, in such Mathew effect in science links up okay, the functions of redundancy in science well similar discoveries are made by two or more scientists working independently I mean it refers to multiple discover each okay.

The probability that they will be promptly incorporated into the current body of scientific knowledge is increased, the more often our discovery has been made independently the better at its prospects of being identified and used. If one published version of the discovery is obscured by noise in the communication system of science then another version may become visible okay, and this lives as with an unresolved question that is what is that unresolved question which

Martin poses that that how can one estimate what amount of redundancy is independent in independent efforts to solve a scientific problem we will give maximum probability of solution without in telling so much replication of effort that the last increments will not appreciably increase the probability okay.

That is a significant question on how can one estimate what amount of redundancy in independent effort to solve a scientific problem. We give maximum in a probability of solution without including so much replication of effort that the last increments will not appreciably increase the probability, I mean this question perhaps was not resolved by Martin research okay, in examining the functions of the Mathew effect for communication enzymes, now let us refine this conception a little further okay.

It is not only the number of times the discovery has been independently made and published that affects its visibility but also the standing within the stratification system of science, I mean times also is stratified that is why it is unequally distributed only in it is distributed in an uneven manner okay, that is why I just said that it is I mean it is not only the number of times a discovery has been independently made and published that affects its visibility.

But also the standing within the scientific I mean within the stratification system of science of the scientists who have made it to put the matter with undue simplicity a single discovery introduced by a scientist of established reputation may have as good a chance of achieving and a high visibility as a multiple discovery variously introduced by several scientists no one of whom has it achieved a substantial reputation.

Although the general idea is at this writing, at this distance discussion okay, tentative it does have the not inconsiderable virtue of lending itself to approximate test. One can examine citation indexes, indices indexes to find whether in multiple discoveries by scientists of mark unequal rank and file okay, it is indeed the case that work published by the scientists of higher rank is the more promptly and more widely cited to the extent that it is the findings will shade some light on the unplanned consequences of such stratification system for the development of science. Interviews that Jack Ermine and Martin conducted with which Nobel laureates which scientist about their reading practices can also supply data bearing on the on such hypothesis okay, this and such tentative solution to a problem or hunch okay.

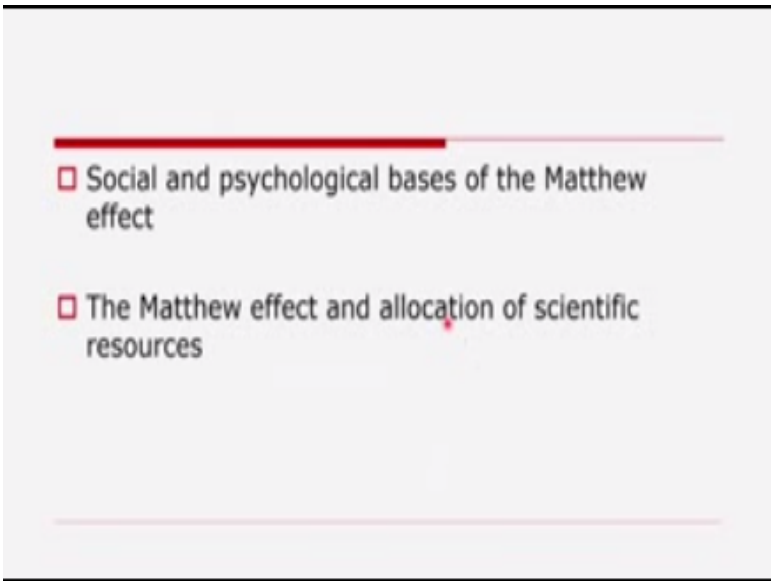
So much for the link between the Mathew effect and the functions of multiple discoveries in increasing both the probability and the speed of diffusion of significant new contributions to science the Mathew effect also links up with the finding reported elsewhere that great talents in science are typically involved in many multiple discoveries, the statement holds for Galileo and Newton for Faraday and Clark Maxwell for Hook and others and also for most Nobel laureates okay, according to Martin okay.

It holds in sort for all those whose place in the pantheon of science is largely assured however much they may differ in the scale of their total accomplishment, the greatness of these scientists rests in there having individually contributed a body of ideas methods and results which in the case of multiple discoveries has also been contributed by a sizeable aggregate torque of less talented individuals okay, scientists.

For example, we have found that I mean for example you will find that more scientists they get lesser amount of rewards and recognition and a very, very few scientists well known scientists those who have already got name and fame they are endowed with more and more rewards and recognition such inequality persist. By examining such studies now we can detect some underlying psychosocial mechanism, psychological as well as social mechanisms that make for the greater visibility of contributions reported by scientists of established reputation, this greater visibility is not merely the result of hallow effect such that their personal prestige rubs off on their separate contribution.

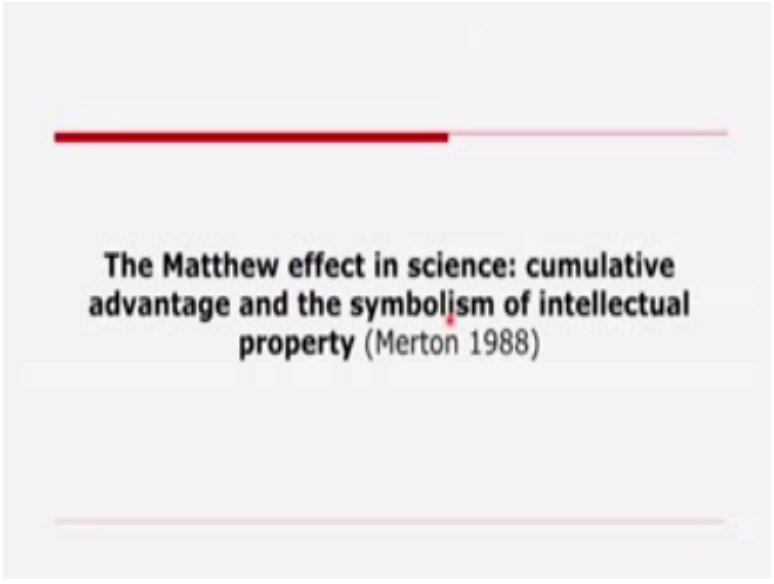
Rather certain aspects of their socialization their scheme of values and their social character account in part of part for their visibility of their work okay, having discussed I mean we have till now we have discussed the reward system in science, the Matthew effect in the reward system, the Mathew effect in the communication system and the Mathew effect and the functions of redundancy.

(Refer Slide Time: 15:42)



Now let us see the social and psychological basis of the Mathew effect and then we will discuss the Mathew effect and allocation of scientific resources before moving on to the Mathew effect in science I mean how the cumulative advantage and the symbolism of intellectual property I mean they are exhibited in terms of Mathew effect science okay.

(Refer Slide Time: 16:01)



But before building up on cumulative advantage and symbolism in the intellectual property or symbolism of intellectual property we will discuss the social and psychological basis of the Mathew effect, you will when okay, some of the contributions have been independently made by an aggregate of other scientists okay, the great scientist or the scientist who has already acquired that eminences okay, such distinctive function it makes a difference.

And often a decisive difference for the advancement of science okay, whether a composite of ideas and findings is heavily concentrated in the work of one scientist or one research group okay, or is thinly dispersed among a great number of individual scientists as well as organizations or research institutions or university okay.

Such a composite tends to take on a structure sooner in the first instance than in the second it requires the Freud psychology of mind a study of mind Sigmund Freud okay, it required a Freud for instance to focus the attention of many psychologists upon a wide array of ideas which as has been shown in soon in many, many works had in large part also been hit upon by various other scientist such vocalizing may turn out to be a distinctive function of eminent persons of science and in eminent practitioners of science okay.

I mean such one Freud okay, I mean Freud was one you may say now for me may others another okay, Del Brooke manner I mean they make a charismatic role in science, I mean the way we talked about the paradigm Kuhn paradigms in science I mean colony Copernicus in astronomy okay, then Galilee also of course came in astronomy, Newton and Einstein in physics okay, Darwin in biology okay, they played the charismatic role enzymes, they played a leadership role in science okay, such paradigms excite intellectual enthusiasm among others who ascribe exceptional qualities today, not only do they themselves achieve excellence they have the capacity to evoke excellence in others it is very important.

In the compelling rage of arm one Nobel laureate with whom Zukerman conducted an interview okay, I mean he said that Nobel laureate said now they provide of bright and being such paradigms such paramedic figures, such charismatic leaders they provide a bright and then it is not so much that these great practitioners of science pass on their techniques methods, information and the theory 2 no biases okay, working with them more consequently they convey to their associates the norms and values okay, that govern scientific research.

I hope by now you know the normative structure of science institutional imperative of science ethos of modern science outlined by Martin okay, I mean universally communism disinterestedness and organization skepticism that we have already discussed okay, that is why the great practitioners of science the eminent scientists okay, they always they often convey to their associate the norms and values that govern scientific research, often in their later years or after their death okay, this personal influence becomes routinized in the fashion described by Max Weber for other fields of human activity charisma okay, become institutionalized in the form of schools of thought and research establishments.

In fact Max Weber characterized different types of authority they be traditional authority maybe rational-legal authority or maybe charismatic authority and what Martin was trying to refer to what Martin was trying to make a reference to okay, that was whether in person of charismatic authority which bear state said it maybe charismatic authority or industry okay. The role of such charismatic leaders okay, such outstanding practitioners of science in influencing younger Genesis associates is repeatedly emphasized in the interviews with Nobel laureate conducted by Harriett Jacob.

Almost to an individual they lay great emphasis on the importance of problem finding I mean that is what we have we have learnt that identification of a problem research question in sciences is very important okay, not only problem solving okay I mean you have to first of all identify a problem and then you have to solve that okay. They uniformly express the strong conviction that what matters most in their work is a developing sense of test of judgment okay, in seizing up on problems that are of functional or fundamental importance okay.

And typically they report that they acquired this sense of test, the sense of judgment okay, for the significance problem during that years of training in evocating environment, reflecting on his on their years reflecting on if a novices, if a junior scientist okay, was not yet acquired such name, fame, reward, recognition and so on okay, and I mean reflecting if you have some a junior scientist reflects on such practices okay in the laboratory of chemists of the first rank one laureate as German books.

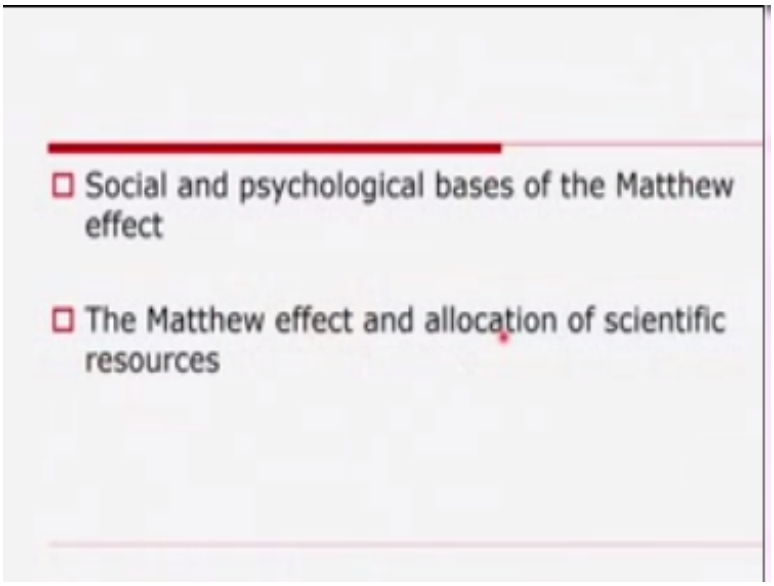
It reports that she or he led me to look at look for important things whenever possible rather than to work on end list details or to work just to improve accuracy rather than making a basic new

contribution okay. Another Nobel laureate described her or his socialized in a European laboratory and there and let me quote here as my first real contact with first-rate creative minds at the high point of their power I acquired a certain expansion of taste it was a matter of taste and attitude and to a certain extent the real self confidence.

I learned that it was just as difficult to do an unimportant experiment okay often more difficult than an important okay, I mean what we are getting from this quotes I mean from this from this interview where conducted by Harriet Jacobin okay, there is one rough measure of the extent of which the laureates were trained and influenced in particularly creative research environment the number of laureates each worked under what to under in earlier years okay.

Now apparently it is not only the experience of the laureates and presumably other outstanding practitioners of science.

(Refer Slide Time: 24:55)



In these environments that accounts for their tendency to focus on significant problems and so to affect the communication function of the material effect such an aspects of their character also play a part in this in df with a few exceptions these are practitioners of exceptional ego strength their self assurance finds varied expression within the context of science as a social institution that is why from the very beginning we have said science is the social institution science into the social crease okay.

And that social institution as we know includes a norm calling for autonomous and critical judgment about one's own work and the work of others okay with their own tendencies reinforced by such not the laureates exhibited distinct self confidence which at the extreme can be loosely described as attractive arrogance okay they exhibit a great capacity to tolerate frustration in their work absorbing repeated failures without manifest psychological damage I mean let me let me quote again one laureates view okay.

Research is a rough gain you may work for months or even a few years and seemingly you are getting nowhere it gets pretty dark at times then all of a sudden you get a break it's good to have somebody around you to give a bit of encouragement when it is required though attentive to the cues provided by the work of others in their field the novelist's are self directed practitioners of science moving confidently into new fields of inquiry.

Once they are persuaded that a previous one has been substantially mind in these activities they display a high degree of Ventures unfortitude they are prepared to tackle important though difficult problems rather than settle for easy and secure ones thus a laureate as government puts it I mean recalls having been given early in his tenure a problem about which there was no risk.

All I had to do was to analyze the chemical composition of substance material you could not felt because the method was well established but I knew I was going to work on something else instead and the whole thing would have to be created because nothing was known about it she or he then went on to make one of her or his primary contributing from the more risky field of investigations I mean one cannot keep herself or himself with the existing methods with the existing problems one must go beyond the existing methods one must go beyond the existing areas of research question okay.

This mark ego strength links up with this scientist collection of important problems in at least two which being convinced that they will recognize an important problem will they encounter it they are willing to bite their side and not settle too soon for a prolonged commitment to a comparatively unimportant one that capacity for delayed gratification cope will do it that our capacity for delayed gratification coupled with self assurance leads to a conviction that an important problem will come along in due course and that when it does their acquired sense of pest will enable them to recognize it and handle it.

This such attitude that ego strength okay has been in reinforced by their early experience in creative environment their association which emulate scientist has demonstrated through their talented novices as digestive screeching never could now that she or he can put a set her or he's sights high and still cope with the problems that she or he chooses to study emulation is reinforced by observing successful though often delayed outcome indeed the idiom of the laureate reflects this orientation they like to speak of the big problems and the fundamental ones the important problems and the and the beautiful ones.

The these they distinguish from the pedestrian work in which they engaged while waiting for the next big problem to come their way as a result of all that okay as a result of all these their papers are act to have the kind of scientific significance that makes an impact and other scientists tend to single out their papers for special attention. The characters structure of these leading scientists may contribute to the communication aspect of the material effects instinct another way which has to do with their mode of presenting their scientific work okay.

Confident in their powers of discriminating judgment a confidence that has been confirmed by the responses of others to that previous work they taint in their exposition to emphasize and develop the central ideas and findings and to play down peripheral ones this serves to highlight the significance of their contributions raising them out of the stream of publications by scientists having less social evaluated self-esteem who more often employs routine exposition.

Finally such character structures and an acquired set of high standards often leave these outstanding scientists to discriminate between work that is what is publishing and that which now in that candid judgment is best left unpublished though it could easily find its way into print the laureates and other scientists of stature often report scrapping research papers that simply did not measure up to their own demanding standards or to those of their colleagues okay.

I mean if you if you look at this I mean outstanding scientists of eminence okay tend to develop an immunity to unsalable I mean in Sanibel mean they each to publish okay now since they since such outstanding scientists they prefer their published work to be significant and truthful rather than merely extensive that contributes interactive matter.

This in turn reinforces the expectations of their fellow scientists that what these eminent scientists publish at least during their most productive periods will be worth close attention once

this once again this makes for operation of the massive effect as scientists focus on the output of such eminence whose outstanding positions in science have been socially validated by judgments of the average quality of their past work and more closely the other scientists attend to this work the more they are likely to learn from it and the more discriminating their response is absolutely.

For all these results cognitive material presented by an outstanding scientist may have better stimulus value than roughly the same kind of material presented by an obscure one okay a principle which provides the psycho sociological I mean I mean socio-psychological basis for the communication function of the method effect and this principle and this principle represent a special application of the self-fulfilling prophecy somewhat as we see in the Paradise I mean a paradigm maybe Copernicus or Ptolemy or Newton or Einstein or Donald okay.

In this context it is it is important that that like other self-fulfilling prophecies such social and psychological basis of the massive effect okay this one I mean this one becomes dysfunctional understand certain conditions for all the eminent scientists may be more likely to make significant contributions they are obviously not alone in making them okay, booster all scientists do not begin by being eminent.

The history of science abounds in instances of basic papers having been written by comparatively unknown scientists okay only to be neglected for years consider the case of what is step that Martin has cited that whose classic paper on molecular velocity was rejected by the Royal Society as nothing but nonsense or of Mendel who deeply disappointed by the lack of response to his historic papers on heredity refused to publish the results of his further research or off or years whose classic paper on the propagation of heat in had to wait 13years before being finally published in by the French academy okay.

I mean then what when the material effect is thus transformed into an idol of authority okay non-recognition off of scientific works okay it violates the norm of universality embodied in the institution of science and the advancement of knowledge but next to nothing is known about the frequency with which these practices are adopted by the editors and referees of scientific journals okay and by other gatekeepers or other so-called gatekeepers of things according to matter okay this aspect of the workings of the institution of science remain remains largely a matter of anecdote and heavily motivated because it okay.

Now having discussed such social and psychological basis of the material effect in science let us move our attention to the massive effect and how scientific resources have been allocated in this okay the material and allocation of scientific research okay one institutional version of the making expect apart from its role in the reward and communication systems of science as we have already discussed requires at least a short review.

I mean this is expressed in the principle of cumulative advantage that we are going to discuss in the lectures to follow on cumulative advantage and symbolism of intellectual property okay such institutional version is expressed in the principle of cumulative advantage that operates in many systems of social stratification to produce the same result the rich get richer at a rate that makes the poor become relatively poorer.

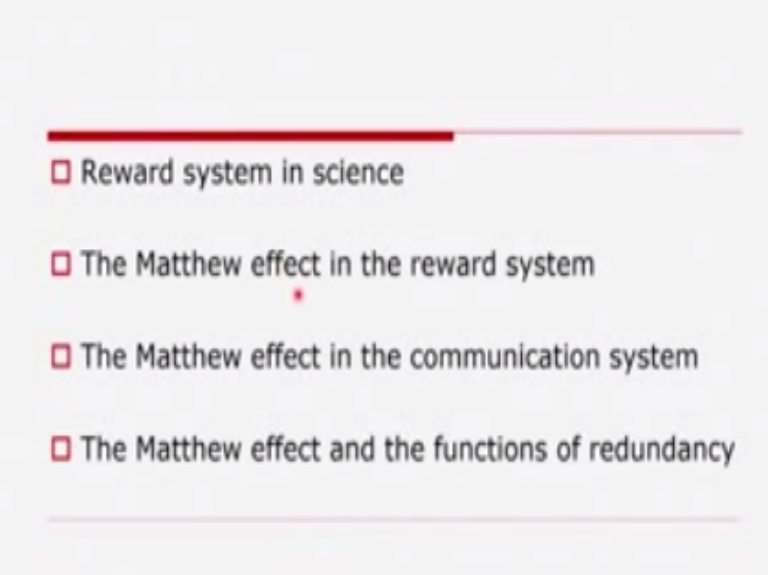
The centers the centers of demonstrated scientific excellence are allocated for larger resources for investigation than centers which have yet to make their mark in turn their prestige attracts a disproportionate share of the truly promising graduate students this disparity is found to be especially marked at the extreme six universities namely Harvard Berkeley Columbia Princeton California Institute of Technology.

And Chicago which produced according to Myrtle 22% of the doctorates in the and biological sciences produced fully 69% of the PhDs who later became Nobel laureates more over 12 leading universities managed to identify early and to retain on their faculties these scientists of exceptional talent they keep 70% of the of the future laureates in comparison with only 28% of other PhDs they have trained.

And finally the top 12 universities are much more act to recruit from other American universities than they are other recipients of the doctorate half the laureates who had trained were trained outside the top 12 and who worked in a university moved into the top 12 but only 6% of the sample of the doctoral recipients did so Merton very open judgment finding to make such statements and these social processes or psychological processes open which we try to allocate our resources okay these social processes of social selection that detained the concentration of top scientific challenge create extreme difficulties for any efforts to counteract the institutional consequences of the Mathieu principle in order to produce new centers of scientific excellence.

Now still now then what we have discussed I mean we have discussed in the reward system in science the Matthew effect in the reward system the Matthew effect in the communication system.

(Refer Slide Time: 39:03)



And the net effect and the functions of redundancy and then we have discussed social and psychological basis of the Matthew effects the Matthew effect and allocation of scientific resources which is uneven which is based on inequality I mean this is this exercise we are doing to reflect on the kind of inequalities which is very much prevalent in the world of science and also among the practitioners often okay. Such account of the natural effect is another I mean is a small exercise in the psycho sociological analysis of the workings of science as a social institution.

The initial problem is transformed by a shift in theoretical perspectives as originally identified the matching effect was construed in terms of enhancement of the position of already eminent scientists who are given a mean I mean were who are given disproportionate credit in cases of collaboration or of independent multiple dis-coverage okay, its significance was thus confined to its implications for the for the doer system in time this summarize.

And we are now trying to summarize the entire a such six point okay six bullet points that we have which we have discussed by shifting the angle of vision we note other possible kinds of consequences this time for the communication system of science I mean I mean by shifting the

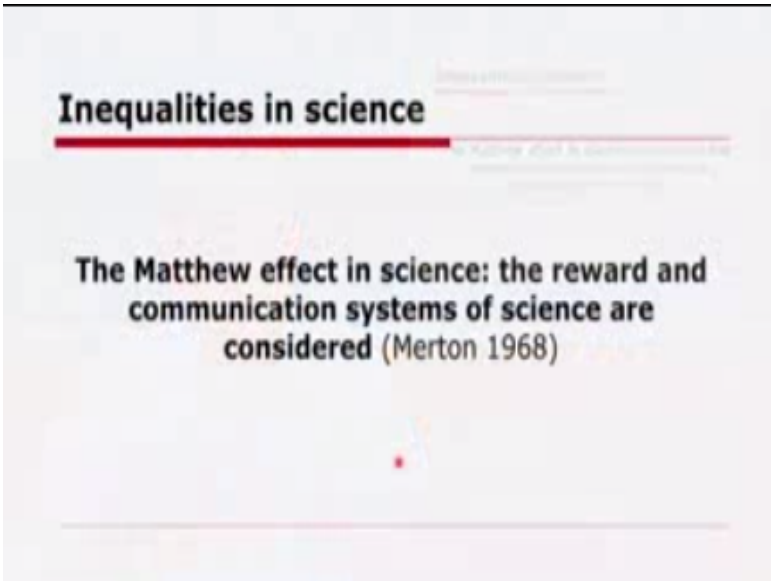
angle of vision we note other possible kinds of consequences and this time for the communication system of science.

The material facts may serve to heighten the visibility of contributions to science by scientists of acknowledged standing and to reduce the visibility of contributions by authors who are less well known we let what we have done that we have examined the psychosocial conditions and mechanisms I mean mechanisms underlying this effect and find a correlation between the redundancy function that that we have already discussed the massive effect.

And the functions of redundancy that the redundancy function of multiple discoveries and the focalizing function of eminent practitioners of science that is a function which is reinforced by the great value is that these practitioners place upon finding basic problems and by their self assurance.

This self assurance which is partly inherent partly the result of experiences and associations in creating in creative scientific environment and partly a result of larger social validation of their position if they it encourages them to search out risky but important problem significant problems and to highlight the results of their influence of macro social season of the Matthew principle is apparently involved in those processes of social selection that currently lead to the concentration of scientific resources and talent okay, then having dispersed how material effect in science I mean how it captures.

(Refer Slide Time: 42:40)



I mean the reward and communication systems I mean how it captures both reward and communication systems of science we will move on to the metal effect in science okay and within that we'll discuss cumulative advantage and the symbolism of intellectual property which Merton discussed okay after 20 years of his engagement with the material fact in science which inequality okay yeah first one he published in science the journal fines in 1968 and then he published in papers in ICS in 1988 okay.

It is it is very important to look at look at the metal effect in science I mean passed to if I take you take the first one as part one I mean the inequality in science I mean the reward in communication systems of science as part one and in the I mean Martin took cumulative advantage and the symbolism of intellectual property as part two okay.

And then in this what we are going to discuss we are going to discuss the matching effect broadly the accumulation or advantage and disadvantage for scientists okay within the rubric within the broader framework of science itself the accumulation of advantage and disadvantage among the young I mean the junior scientist then the accumulation of advantage and disadvantage among scientific institutions organizations research institutions and so on universities.

Then what are the countervailing processes and bring the symbolism of intellectual property in science okay and the time of symbolic union of intellectual property in science that we are going to discuss okay but in detail will discuss how science which has either to be a public resource has been transformed into an intellectual property we will discuss this further the last lectures okay you know that is the last modules we will discuss okay in this context we will start with overall the Matthew effect.

Centre for Educational Technology
IIT Guwahati
Production

HEAD CET
Prof. Sunil K. Khijwania

Officer- in- Charge, CET
Dr. Subhajit Choudhury

CET Production Team
Bikash Jyoti Nath
CS Bhaskar Bora
Dibyajyoti Lahkar
Kallal Barua
Kaushik Kr. Sarma
Queen Barman
Rekha Hazarika

CET Administrative staff
Arabinda Dewry
Swapan Debnath