

**NARRATOR:** Live from Cambridge, Massachusetts, the CBS Television Network presents *ds equals dQ over t and YOU!* Which means-- well, you'll see in a moment.

Our story begins on the campus of the Massachusetts Institute of Technology, which this week starts celebrating its 100th birthday. This is the official residence of the president of MIT, Dr. Julius A Stratton.

And here is Dr. Stratton.

**STRATTON:** I see at this beginning of our centennial celebration. And, especially, I want to welcome the distinguished scientists and educators who today are gathering in Boston and Cambridge from all over the world. Over the next few days, they are going to look searchingly into the problem of how the advances of science, of engineering, and of education may be directed forcefully toward the good of mankind.

This afternoon, Mrs. Stratton and I are privileged to have as guests in our home six of these conferrees, whose discussion you are about to hear. And, to introduce them to you, here's your host Charles Collingwood.

**COLLINGWOOD:** Thank you Dr. Stratton. We're grateful to you and to Mrs. Stratton for letting us monopolize your guests this afternoon and your living room. Let me introduce our guests to you.

First, Sir Eric Ashley, Master of Clare College, Cambridge University in England. Il Rabi, Nobel Prize laureate, Higgins Professor of Physics at Columbia University. John E Burchard, Dean of Humanities and Social Sciences here at MIT. Raymond Aron, Professor of Sociology at the Sorbonne, the University of Paris, and one of France's most respected and influential journalists.

Americans are apt to call Monsieur Aron the Walter Lippmann of France. I don't know whether Frenchmen call Lippmann the Aron of America, but we're very glad to have him here. Dr. Jerome B Wiesner, who, three months ago, was appointed President Kennedy's assistant for science and technology. And Jerrold Zacharias, an outstanding nuclear physicist, who at the moment heads the physical sciences study committee.

Our title probably sounds confusing to most laymen. It's certainly confusing to me. We chose it for that reason, because science is confusing to most laymen. Yet, we are entering upon an age of science, embarked on a scientific revolution, which most scientists agree will have effects as far-reaching as those of the Industrial Revolution.

Our guests today come from three of the great democracies of the world. So we're going to ask them how government by the people can best adapt itself in an age in which the great policy decisions-- are many of them life-and-death decisions-- depend on scientific facts and formulations, which are to most of us very difficult to understand.

Now, Monsieur Aron, you are a layman. You're not a scientist, but you are an incisive commentator upon political processes, sometimes a critic of them. Do you find that your own ability to criticize and understand this political process is hampered by the fact that you are not a scientist?

**ARON:** In other term, you ask me if I think I can be a political commentator without being a scientist. If I would answer "no," nobody would believe that I am sincere. If I answer "yes," I will look rather immodest, but still I would take my risk. And I will say I believe it is possible. Of course there are many circumstances in which I would like to have more scientific background-- to know more about science and to rely less on information.

But there are many other things I would like to know and which I ignore. As example, I would like to read Russian to be able better to understand the Russians. There are many things which anybody is obliged to ignore in the present world so in certain cases it would be important, but still I believe political comment is possible, even for the layman. And as far as I know, there is not a single political commentator who is a scientist.

**COLLINGWOOD:**Dean Burchard, do you agree-- Dr. Rabi?

**RABI:** I would like to ask Monsieur Aron a question. There is a very important political problem on which I'm sure he'd be willing to comment. And that is the attitude of France with respect to the test moratorium on nuclear weapons. This is a subject which goes very deeply into military science and physical science. And, I would like to see an example of how he feels he can comment on that, without some kind of scientific background acquired by some means or other. Perhaps he could give us a living example giving his view of the French attitude toward the test ban.

**ARON:** Yes. I don't think that the question is completely fair because in order to answer the problem, what is the reason for the French attitude, I would need to enter into the psychology of the French nation, the psychology of General de Gaulle, the possibility of very small- or medium-sized nation to acquire atomic armament, and so on, and so on-- which is not impossible, even for a layman, but which would take a lot of time.

So, to answer simply, I would say, as long as there is no test ban, it's perfectly simple to understand why General de Gaulle is maintaining his present attitude. Because if a test ban is signed, there will be negotiation between Washington and Paris. There is no reason to give up the cards before the negotiation. And if there is no test ban, why should France accepted a test band which does not exist?

So the present situation does not require very high scientific training, just a little common sense. That is an example in my direction.

[INAUDIBLE] [LAUGHTER]

**COLLINGWOOD:**Let-- let me, let me pose a simpler question just turned around to our own country to Dr. Wiesner who has responsibility for advising the government of the United States on these matters. Can the people who govern the United States make determinations on such matters, which are typical, I guess, of a certain range of problems they have to face, as a nuclear test ban, without having real scientific training? Or is the advice of people like yourself enough?

**WIESNER:** Well, that's a hard question to answer. I think, in some instances, people who have to make the decisions in the end, such as the president, would be more comfortable if he had firsthand understanding. On the other hand, he does have available to him a large number of people whose judgments he can hear. And, in the end, he has to make his own decision.

But one of the things to realize is that even people with scientific training and background don't agree on most of these matters. And so they're not, as Dr. Aron-- Monsieur Aron-- has said, are not fundamentally scientific questions. We can agree on them as scientific matters and still have tremendous arguments about the military implications and the political implications of the problem we're talking about.

**ZACHARIAS:** Can I get into this for just minute.

**COLLINGWOOD:** Yes, Dr. Zacharias.

**ZACHARIAS:** I would rather say it this way, I would rather say that one man's expert is another man's layman. And in trying to come to some kind of understanding of a question as difficult as any one of the-- well, the one that was posed or any similar one-- you can't do it out of some, simply out of a scientific background, or of a background of being an economist, or a journalist, or a political scientist, or a historian, or a litterateur, or any such thing, or a politician.

It takes experience over all of these fields and sometimes you'll find some in all sorts of people involved in making the decisions. And the more experiences there are in any one person, the sounder judgment, or the sounder material he can present, to a concerted discussion of any issue.

**COLLINGWOOD:** Well would you say Dr. Zacharias, then, that ours is really the right system. That in instances where scientists may disagree on the same kind of basic appraisal of the situation, that the right place for the decision to be taken is by the layman-- the political personality whom we have given, as a nation, the power to make these decisions.

**ZACHARIAS:** No. All I was saying is that under any complicated situation, everybody is both expert and layman together. And the more different disciplines that that man has mastered, and is familiar with, and is used to, more different kinds of coloring that comes to forming his opinion, the sounder his opinion is likely to be. And I'm not saying that the politicians should be laymen in science, nor should they be experts in science. They should be literate in science, but they should be literate in economics, in literature, and so on.

**COLLINGWOOD:** Does that command itself to you, Sir Eric?

**ASHLEY:** I don't think so. Not if you mean, by literate in science, able to pass examinations in it, which is the way we measure literacy.

[LAUGHTER]

**ASHLEY:** I should have thought that the decider, if I can put it that way, the man who has to make decisions doesn't need to know science at all. He's really, to my mind, something rather like a very complicated digital computer-- a calculating machine. And his job is to see that material is programmed properly when it comes to him.

And that's an art, and it doesn't require any special knowledge of science. It requires much more a knowledge of the psychology of scientists. And then he's somehow got to integrate this material-- these messages he receives from experts into a viable, politically viable result. And that doesn't seem to me to be a quality that calls for any special scientific training at all.

And I would say that, to a certain extent, the more science a senior administrator knows, the more he must've neglected other things far more important for his job. So I would go, rather, into opposition--

**ZACHARIAS:** It depends on what type of examination you require him to pass. By literacy, I mean the ability to read science as one can read history. Scientists can pick up a history book, now, read it, understand it, know what's there, know a lot of the flavor. And this-- all I demand, or not even-- all I would like to see is the, is an equivalent literacy in all sorts of fields. However, you can't do everything.

**ASHLEY:** Can you take the jargon out of science? There's not much jargon in history.

**ZACHARIAS:** I think the title of this raid-- this television program is it reduces this jargonism to a almost a ridiculous point.

**COLLINGWOOD:** Well, but yet--

**ZACHARIAS:** And we've got to do that, and I'm sure we can.

**COLLINGWOOD:** But yet Dr. Zacharias, Sir Charles Snow in pointing up the difference between the two cultures-- the scientific and the humanitarian culture-- says that this formula, which is the second law of thermodynamics, is equivalent to knowing a work of Shakespeare-- is equivalent in the scientific world to knowing a work of Shakespeare. But how many nonscientists know it? And that-- he says that it's not ridiculous at all.

**ZACHARIAS:** It's like saying that you know Hamlet if you know the words, "to be, or not to be." There's a lot more to Hamlet.

**COLLINGWOOD:** And there's a lot more to science.

**ZACHARIAS:** And there's a lot more to the thermodynamics underneath this equation too.

**COLLINGWOOD:** Dr. Rabi, how much should a-- how much should an ordinarily well-informed citizen of a democracy today know about science?

**RABI:** I think he should know enough about science to get a considerable amount of pleasure out of reading about science. To be able to understand trends in some field of science to the degree that he would enjoy it and partake in some part of the tremendous vigor of this movement and of the great excitement, and the optimism, which is engendered in that.

I think it's a great weakness of our whole culture at this part of the century that there are so so many people are ignorant of this great force that's giving vigor to our period, and therefore become a lost generation. They're pessimistic, and see nothing at all that's thrilling, and don't realize the greatness of the period, and tend to look at the past or take refuge in some kind of disengagement.

**COLLINGWOOD:** Well, now, Dr. Burchard teaches scientists humanities. What do you think on this, Dean Burchard?

**BURCHARD:** Oh, just exactly the way they do. I think the scientists have much less need of the humanities than the humanists have for science. But I would like to put a footnote on to what was-- Zach was saying and see if he would agree to it. I should think the most dangerous leader I can imagine, would be a leader who knew a little more science and didn't know how little he knew.

Now, I think of the great Winston Churchill. He thought of himself as a strategist and a military figure, and the Gallipoli Campaign came out of that, and some other smaller events that aren't so well-known. Supposing he'd known a little more science, the recent snowstorm about [? Lindemann ?] and [? Tizard ?] would have been a blizzard.

See, I really think this would be the dangerous thing. And to have the man, then, who can understand, and then can have expositors. And there's one right there, Professor Wiesner is a great expositor. And if these are first-class expositors to an intelligent leader, I'd be-- feel safer with that, unless he knew an awful lot-- and I think this is going to be hard [INAUDIBLE]

**ZACHARIAS:** Can I-- there's a little point of disagreement here, at least on my part. I think Professor, Dean Burchard has implied that the man who knows a little something is automatically immodest about his attainment. And I believe, you know, that old wheeze, drink deep, or taste not, and so on. If you know that you don't know, if you know that you haven't full understand, you can still know a little and it helps.

And it's my feeling that in some-- in some field or other, it is terribly important to have dug deep enough, so that you know deeply in yourself what it means not to understand. Then you can come, modestly, with a small amount of information of any other sort.

**COLLINGWOOD:** Dr. Wiesner?

**WIESNER:** There's another reason why I think it would be very useful for everyone to have studied some science and understood the processes. And that is to understand the scientific method, because to too many people science is magic and the scientist is a magician. And, as a matter of fact, he's not.

He has a good education, he knows the background of this field, and he knows a method of operation which leads on in the exploration of nature from one point where he is to a next point. And I think if people had a better feeling for the scientific process-- the fact that it involves an interrelationship of experimentation and deduction and making many errors-- that people usually think the scientist proceeds logically from one place to another as a result of very great mental power.

As a matter of fact, the scientist usually sort of wanders along a given path, making errors as he goes, finding his way. And if there was a deep seated understanding of the nature of this process, I think people would have a very different attitude towards science and what science can do.

**COLLINGWOOD:** Monsieur Aron, you once said that the problem of education in the United States is really the problem of educating the president of the United States, Mr.-- Dr. Wiesner's boss. What did you mean by that?

**ARON:** What I had in mind is a fundamental problem of politics. In politics, it's inevitable that the key man should not be a scientist, because even if by accident he has some scientific training, a special job-- a special expertise-- is to handle men and to come to the top.

To be a political man, it's only an accident, good or bad, if a scientist is at the same time a political man. We had only one experience of that in France. It was a famous mathematician, Painleve, who, at the same time from a certain age, become a professional political man. But whatever the political regime, decisions are taken by amateur or by limit. Inclined to limit.

And the question in my mind was, what must the president of the United States know in order to be able to take reasonable decisions. And I would say more or less what everybody has said here, a sort of fundamental ideal of what science is-- of the method of science-- is extremely useful. But other things are also useful.

So I would say that it is possible to train the people for any job, but for the job of the president of the United States because there is no training which can be said to be absolutely necessarily, absolutely indispensable, and there are a lot of thing which are useful.

**RABI:** I would disagree, because I think the president of the United States in the middle of 20th century should be a 20th century man. And he cannot be a 20th century man without having culturally participated in this rigorous movement of the modern age.

Of course he will do the job. I'm comparing doing the job with some ideal of excellence. For example, we say the president of the United States should be an American. We wouldn't pick a Chinese or a Russian out of that culture for this. As a matter of fact, the constitution specifies that he should be born in the United States.

This does not mean that he's a person with a tabula rasa, such as my colleague here has indicated-- some sort of adding machine. He's a particular kind of adding machine. He has come out of a certain environment. What I was trying to say is that that environment should include science very centrally.

**ARON:** May I ask a question? Because-- to know if we disagree or not. You have used an expression which is at the same time clear and slightly unclear, which is, "participating in." What do you mean by "participating in" the movement of science. In a certain way, I admit the proposition. But I would like to know what you mean exactly by, "participation." From what level on do-- would you call it participation?

**RABI:** It can be various levels, as long as there's some perception. For example, if a boy goes to a good school, at some point he should try to write a composition, he should, perhaps, try to write some verse. Then he might have some understanding of what this creative side mean.

And likewise I feel he should go far enough in science in some way so that he has done something, no matter how little, provided under a proper teacher. It would give him some feeling for it, not as a method. The method of science is so easily described and, yet, it eludes you in description, just like any other deep cultural thing that can mostly be learned by imitation. There's a long oral tradition which has a certain difficult penumbra. That's how far I'd like to have him go.

**ARON:** Yes, in that case I would be ready to accept it--

[INTERPOSING VOICES]

**COLLINGWOOD:**What about Sir Eric?

**ASHLEY:** Well, very far from inside--

**COLLINGWOOD:**What about Sir Eric? Do you think he needs to know that much or have that much experience in the scientific method?

**ASHLEY:** Well, doesn't raise a major educational problem? I think Snow has made a fundamental mistake when he said that everybody should understand the law of-- laws of thermodynamics. That I don't think is what matters.

What matters, I think, is that the ordinary man, the nonscientist, ought understand why is there such a consensus of opinion about the law of thermodynamics. So that's the magical thing, the remarkable thing. And therefore, it looks as if our whole educational system for the ordinary man who isn't going to be a professional scientist ought to be such that it teaches him how the scientist thinks and works.

[INTERPOSING VOICES]

**ASHLEY:** Now can you do that?

**RABI:** I doubt whether understanding why the consensus exists will help them. We don't really know. We understand why the consensus exists in certain religions-- the top man has said, this is the doctrine.

That is not so in science. And many people will dispute that there was a consensus when a new doc-- when a new idea comes up that the older people ever converted to it that you don't have to wait until they've passed out of the picture.

**ASHLEY:** But isn't there a great internal consistency in many sciences--

**RABI:** Of course there is, of course there is--

[INTERPOSING VOICES]

**ASHLEY:** --and isn't that what the ordinary man ought to understand.

**RABI:** I doubt whether the ordinary man could really understand this without having participated to the degree which I have described, if more, unless he's been really engaged in this effort. And I would differ with you further. I would say the great reform we need is to make science the core subject in our education.

**BURCHARD:** Well, now that's what I really was trying to ask you, because this hypothetical president who ought to have somewhat a sense of science than he has, of course, was born in a log cabin, more or less. And he's gone to a school somewhere. And, it seems to me, at this point is where you must start this.

I would guess-- I would think, myself-- that there's a great deal more good writing, intelligible writing, about science today than is being read. And why isn't-- I think it could be read by many more people, and the reason is, somehow, we haven't broken that down. Now, I know the person who's worked very hard to break this down.

I think we do get back to general education of the popular man, because the popular man is the president, ultimately.

**COLLINGWOOD:** Now, you mean, you mean Dr. Zacharias.

**BURCHARD:** Yes. That's right.

**ZACHARIAS:** Let me, let me say this in, I think, a simple way, at least simple to me. If I watch a baseball game, even on television, or read a book about baseball-- and there are some very good new ones-- I get some kind of feel of thrill with it. And when I see-- I don't get the same feeling, I can watch a cricket match. In fact, I don't watch a cricket match.

It's entirely different. Where do-- why do I have a feeling for baseball rather than cricket? They both involve balls and bats and people. One, evidently, is not a game, and the other one seems to catch on over the world. With due apologies. But--

**ASHLEY:** Right, I'm no cricketer.

**ZACHARIAS:** How did it start? When I was a child, I played a little baseball. Not much, I always used to say, I couldn't catch, pitch, run, or hit. But I played some, enough, I watched enough-- I participated in it in that sense. Now I'm not demanding-- and I wish we would get off it's being the president. Or--

**WIESNER:** Yeah, so do I.

**ZACHARIAS:** --I think, we are talking about--

**COLLINGWOOD:** So does Wiesner.

[LAUGHTER]

**ZACHARIAS:** --in all sorts of the office, in all sorts of not office. And I think if you participated to this degree, through the first very formative years of your life.

**COLLINGWOOD:** Well, translate that into what kind of education that would mean.

**ZACHARIAS:** Well. Specifically, I think that education should start at age almost zero. I think it's criminal for us, especially in the US and in most other countries, to throw away those early years, say, from age 5 to age 12, when the minds are very, very-- they're just sponges, they'll do anything. It's thrilling to teach these young ones.

I believe that, as Rabi said, science should be a core subject. Yes, but so should other things too. And you can make a list it's as-- I have it in my little book. The arts, the crafts, the literatures, the languages, the histories, the social sciences, and so on and so on.

You've got to get these things into young minds. And once you've accomplished this, you won't have the kind of argument that we're having.

**COLLINGWOOD:** Well, aren't you really saying the old idea of the well-rounded man. You'd just like to have him round out his scientific education as well. But nothing specifically--

**ZACHARIAS:** It depend-- now, wait. It depends. The well-rounded man usually refers to a man. I was talking about people younger than age 12.

I do not agree that one should they try to study in college and in the university all sorts of things simultaneously. So that, I'm perfectly happy to find, to eventually to die a well-rounded man. But I don't want to swell gradually in all directions at once.

**COLLINGWOOD:** Aron?

**ARON:** I belong to a country where there is neither baseball nor cricket, so I can intervene in the discussion. And, B, I belong to a country where there is a lot of talking about giving too much to the young between the age of 5 and the age of 12, so our problem is rather the opposite of the problem you are discussing.

And, of course, it would be good to have literature, language, science, everything. But, in the end, any problem of either education or politics is a problem of choice because it's probably impossible to have the young man digest everything which would be necessary.

And only if you are able to have at the same time a real scientific culture and a real literary culture. I'm rather in agreement with Professor Rabi. Namely, it would be good to have more science at the center of our system of education. I agree that in the 20th century, it's rather absurd that Latin should be absolutely necessary to enter, let's just say in Oxford, and not mathematics.

I think that's really an absurd position. But, in the end, the fact will remain that many intelligent people will have no real access to scientific culture. And the problem remains for the modern society is these men without great participation in the scientific world are able to be good citizens, good political men, and so on.

**COLLINGWOOD:** Mr. Wiesner.

**WIESNER:** I think Dr. Zacharias would maintain that in the course of a normal elementary school education you could teach the science he's talking about, if one did it properly and one taught modern science, and not the collection of things which used to be called science before science was really understood by the scientists.

**BURCHARD:** And you really think-- and I know you do, and I think you're absolutely right that there's a chance for great excitement, because I've watched some of these little experiments. They're very exciting. But, you know, we do the same thing everywhere else.

You know, still, students in America are still reading that infernal book, *Silas Marner*, an introduction to literature. We've all read it-- a horrible book. And there's no retooling of this either. In this-- you have done some effort to get youngsters interested. I doubt if they're any more interested in literature in the schools than they are in science, now.

**COLLINGWOOD:** Well now-- sorry, Dr. Rabi.

**RABI:** I would like to answer Monsieur Aron, in this sense. It seems to me that if we're going to teach science in the sense in which I'm talking about, one should not teach it in the traditional way, as a collection of facts and ideas. It would have to be taught in a much more humanistic way.

That is to say, its place, it as a part or included in it is the cultural, economic, and other history. Those parts should not be neglected. So while you're teaching a particular science, you are teaching a great deal more than that. I could not conceive of an education which would just be strictly science as found in the textbooks.

That would not be-- that would be an education in the subject, but not quite the education for the human, 20th century human being I'm talking about, because I want to place him firmly in this century while I'm teaching him science. So that I'm talking of a quite different kind of education. And I would say further, perhaps differing from Dr. Zacharias, that I would make this the core subject. Other things would hang on, as we might do now in some schools, let's say those ages, and make Latin the core subject, and fit in other things as they can.

I really mean a revolution in the system of education. I think it's a necessary revolution to get a public, and particularly an educated public, that can begin to evaluate the problems which will appear before them.

And one other word about the politician. I'm hoping that, in time, we'll produce enough scientists so that they'll be running for office, all the way from the mayor of a small town to president of the United States. And you bring science into the body politic by bringing the scientist in as a legislator or as an executive.

**COLLINGWOOD:**By overproducing.

**RABI:** By overproducing. Quite necessary.

**COLLINGWOOD:**You're a sort of bridge between the scientists and the politicians, now, Dr. Wiesner. Do you think that scientists would make good politicians?

**WIESNER:** Some.

**COLLINGWOOD:**Would they?

**WIESNER:** I think so.

**COLLINGWOOD:**Well, why is it, then, that there have been so few?

**WIESNER:** They find their own work more interesting, I suppose. And on the whole, scientists aren't terribly attracted to-- some of the requirements, I guess, of a successful politician in the modern world.

**COLLINGWOOD:**Well that brings me something that I've been wondering about as we've been talking here. We've been talking, mainly, about the responsibilities that devolve upon a citizen in a democracy and his responsibilities in regard to science.

What about the responsibilities that devolve upon the scientist? Doesn't-- if he is going to be the adviser, if he is going to lay out the alternatives for the layman to decide upon, doesn't he have a, have to-- you're shaking your head, Dr. Zacharias.

**ZACHARIAS:** I sure am. You said he lays out the alternatives.

**COLLINGWOOD:**Well, he describes--

**ZACHARIAS:** You're trying to present this poor scientist as a fellow who exists in a vacuum. And somebody comes up to him and says, here's a question. And he goes into a corner, and scribble some equations, and fills in some numbers, and comes up with an answer.

And the questions that face the government are much more elaborate than that and cannot be handled that way in the least. You have to bring all sorts of considerations. You have to bring psychological considerations in. I don't mean psychological considerations out of a professional book on psychology. You have to say-- you have to guess--

**COLLINGWOOD:**All right. Then let me turn

**ZACHARIAS:** --what kind of reaction you're going to get. And this is professionally the job of a politician. But, so, whenever there's a question, you have to pull enough people together so that all sorts of points of view are represented.

**COLLINGWOOD:**But doesn't the scientist, then, doesn't he have to bring to bear on the question some of these other things.

**ZACHARIAS:** Sure!

**MAN:** They do?

**ZACHARIAS:** Certainly.

**COLLINGWOOD:** Do they?

**ZACHARIAS:** Yes. Do they--

**WIESNER:** I think there's one of the most superb politicians I know sitting over there.

**COLLINGWOOD:** Dr. Rabi?

**ARON:** It's kind of surprising that we have discussed this problem of the scientist in politics and completely omitted what is called generally the social sciences. Because, after all, many of the problems--

**MAN:** No, we didn't!

**RABI:** I never did.

**ARON:** No, but--

**MAN:** It's on my list.

**ARON:** --what you call.

[INAUDIBLE]

**ARON:** What we have called scientist [INAUDIBLE] is a physicist or the mathematician. We have not called economist a scientist. And, after all, one of the adviser to the government is certainly either the economist or the sociologist, in spite of the fact that the social sciences are not exactly of the same character as a physical sciences, but certainly they are part of the knowledge which apply to political decisions.

**RABI:** As soon as he calls himself a scientist, we will call him one too.

**ARON:** No because we have a certain inferiority complex--

[LAUGHTER]

**ARON:** --when we are an economist or a sociologists, we refuse to be called a scientist because we have the feeling it would be immodest or we don't know enough to be called a scientist.

But, still, for the president of the United States it's extremely important to know something about recession or about economic affairs and the the rest of that.

**RABI:** We would be the last people to disagree.

**ASHLEY:** I'd like to come back, if I may, for a minute and try and press Dr. Rabi on this problem of the education of the common man in science. I entirely agree that this-- science should be the core of culture. But what kind of science is it to be? Do you think, for instance, that a great deal of practical work is necessary? I do, because I think that the one experience that any research scientist has had is that techniques are enormously important in science. And, unless you get the feel of techniques, you don't know what it's like to think. Would you have a great deal of practical work for your common man?

**RABI:** My own feeling of own experience is that people are so diverse, and some would never learn through practical work, and some would never learn unless they did practical work. I think we just simply have to recognize those differences which exist in the way people learn. Some people simply think with their hands-- some sort of kinesthetic-- and others, only logically.

I've met people who had no concept of plane geometry, although they did well in it in the sense of pictures. That didn't help them very much, it was the logical relation as such, and practical work, obviously, would not be very helpful. Well, not the first approach for such a man. I think we will have to tailor our courses more to the kind of people we get.

**BURCHARD:** I think there's a point there, though, that applies to all subjects. Now, there's a great argument that goes on in the arts as to whether anyone can really ever come to grips with the arts, unless he paints first. This is precisely the same question. I think for some people yes, for some people no. I'm really agreeing with you.

I'd like to come back, if I could, though, for a minute to the scientist in politics, and see if the scientists would agree with me about this. I think that a few years ago, even just a few years ago, this would have been quite difficult, because, I think, that professional men, specialists, have tended to push out of the herd-- specialists who went out and tried to do something else.

And as long as that climate existed, you couldn't expect good scientists to go into politics. I mean, this is changing very rapidly, and a very beneficial thing too. Would you agree with that? Or do you think--

**RABI:** I agree. I think it's great sociological change.

**ARON:** But they are going into politics as expert or advisers, not as political men for the timebeing--

[INTERPOSING VOICES]

**ARON:** --for the time being. And that is very different.

**ZACHARIAS:** Flashback a moment to Sir Eric. I want to interpret, he used an English term, "practical work." In America, this is called laboratory.

**ASHLEY:** Yes, that's what I mean.

**ZACHARIAS:** And--

**COLLINGWOOD:** And in England it's called laboratory.

**ZACHARIAS:** --and when properly used, in my view, a laboratory is neither practical nor work. It isn't just the business of learning skills and techniques-- it can be too-- but most especially, a laboratory is to establish in the student's mind very firmly what the discussion is about-- to establish the characters in the play that they're trying to understand.

And if the play happens to be physics, or chemistry, or biology, and one talks about a cell, say, in biology, or a nerve, or a nerve fiber, or some other such thing, you have to have some kind of experience with it so that it's part of you. And that's what we use laboratory for, and that's why I don't like the British term "practical work."

**ASHLEY:** This is good, I think--

**ZACHARIAS:** It really is misleading.

**ASHLEY:** Can you go on a little further, now, and help us say, well, one thing that certainly worries us a good deal in England-- are two things. First of all that, I think we all agree that everybody ought to learn some science. And yet I read in this morning's newspapers only 6% of children in a high school in the United States do any physics and although they-- a good many of them general science, but even only 30% or so do general science.

In Britain, as you know, an infant at the age of 14 has to make up its mind whether it's going to take the school examinations mainly on the science side or mainly on the arts side. And that very largely determines whether later on if it goes to university it can do science or not science.

Now, why is it in your country and in mine, we've not made science a compulsory part of the curriculum for a great many more years than we do?

**ZACHARIAS:** Take a slightly expanded answer. First, the numbers that you quoted are not really quite right. That is, about 25% of the students in our high schools study a course called physics. However, they have been studying bit, odd bits, of physics all of their lives. Not all in an organized way-- some of it haphazard, and so on-- but they do learn something.

It's my conviction that that percentage should be broadened, ultimately, to 100%-- that there should be physics, and all of the other sciences, and the social sciences, and so on, all through the full education of our students in this country.

But I don't believe that that you do it simply by setting up a course under any circumstance. I claim that in this country, and I'm sure it's true in yours and your, that we suffer worse from the curse of the course credit than we do even from the curse of the course.

Somehow or other you are supposed to have studied something if you have taken a course of it. Now I think this implies already that someone must lead you through the vast maze of materials that should be at hand for learning. But those-- the one who leads you through this vast maze of material available for learning, they don't have to do it with lectures or formal appearing once a week, or twice a week, or five days a week, for the pleasant months.

**WIESNER:** As a matter of fact, the people who learn science best do it on their own. I had a rather shaking experience last week. A bunch of students from one of our best private high schools came to Washington and asked whether I wouldn't talk to them a little bit about science.

And so I met them for a half hour and I said, instead of my talking to you, why don't you ask me questions? So they asked me questions about rockets for about 15 minutes, and I said aren't you interested in science? They were a little shaken and said, what do you mean. I said, well, this isn't really science. And they all sort of guessed this wasn't science. And then we went on and they asked me another 15 minutes worth of questions about rockets.

**COLLINGWOOD:** Well, now, this interests me because what I was going to ask you next was this, we've shown, I think, that we need more science in the education of citizens in all our democracies. How much do we suffer now from a lack of scientific education? Which Dr. Zacharias, and Sir Eric, and others have brought up. How much do we suffer now in the decisions which our democracies are called upon to make? Dr. Rabi?

**RABI:** I think immensely. It just can't be measured. I will give you an example. After President Truman left office, and he was exposed to all the knowledge there was about atomic weapons, and all the knowledge we had with respect to Soviet tests of atomic weapons, he said publicly he didn't believe they had any. After he himself during his administration had ordered a speedup in the study and development of the hydrogen bomb in response to a Russian, first Russian test, afterwards, he said he didn't believe they had any.

Now I think that's one of the clearest instances of a man, such as you've described, who's going to be the focus of all this expert knowledge and making up his mind--

**COLLINGWOOD:** And did make a good decision.

**RABI:** --and did make up his-- won't talk of the nature of the decision, but aren't you somewhat frightened by the fact that a man without the scientific background made this decision and proved later on that he didn't understand a whole series of facts that were presented to him. And it may be it was the right decision, but I don't see how it couldn't have been done just as well by tossing a coin or several coins.

**BURCHARD:** And supposing all the decisions were right, and you had no different structure than you have now, wouldn't you have one of two things? Either a feeling on the part of the public, yes the decisions were right, but we don't know how or why they were made, and consequently either apathy or resentment. And doesn't either one ruin democracy?

**WIESNER:** I think that's one of the very great problems that you have, more and more people are throwing up their hands and saying, there's no point in thinking about the problems of the world today because we can't understand them. There's no point in trying to understand them, no point I'm trying to learn about them. They're now so complicated and involve specialists to a degree that the average citizen can't participate in decisions. I think this is wrong, and think it's very, very dangerous.

**ARON:** I think it's wrong, it's dangerous, but the problem is if we can avoid it. Namely, is it not true that the societies have become extremely complicated? Is it not true that, inevitably, the great mass of the people will feel unable to understand the complicated decisions?

And, after all, the case you mention is a special case because the President Truman as president in action accepted the advice of the scientist, and did take the decision to speed up the effort towards producing arms. What you mentioned after that is a private expression of skepticism, which is extremely surprising because, after all, he acted as if he did believe the specialist.

**BURCHARD:** But, look, hasn't this always been so? When Jefferson bought the whole West, did the American public know what he was buying? Did they know what he was getting into? No. But that was explainable, or at least they thought it was explainable in something like common sense terms. And I think the scientists believe this is now also explainable.

**RABI:** I'm talking something quite different. We have a republican form of government, a representative form of government, where the public elects people to represent them and you presume that as you go up the hierarchy that you get better and better informed people. People who have studied harder, who is someone who had more experience, and the-- hopefully, when you get somewhere near the top that you will have most exceptional people and most representative of the finest qualities of knowledge and character and spirit of the period.

I claim that this cannot be had, unless our educated public gets this in a very large degree.

[INTERPOSING VOICES]

**RABI:** --those who cannot go that far, have neither the talent nor the taste for it, will have less, must have something. Enough to have a certain amount of respect, so that they would wonder whether the man for whom they vote has a proper background-- would have some understanding so that they might listen to him and hear how he stands, what he says.

They elect a man judging by his personality, certain issues, but mostly on his personality-- in this country. I mean it isn't a party list as there are in some other democracies. Now, it's a particular man. Well, you have to judge that man. And you have to have some background for that. The man who's elected has a much greater responsibility, of course, in informing himself.

And you cannot have the whole government run by a degree of disembodied experts, each pressing upon a man who essentially knows nothing, except that he's been elected. That's no system. It's a very frightening prospect in an age of this sort, where his whole system might be upset because of what he had eaten last night.

You're not expecting any contribution from him, unless you give him the proper education. He's just the focus of a number of pressures. Certainly, that's not what you mean, Mr. Aron.

**ARON:** You are going, you are going too far, because you are discussing many question at the same time. You are not satisfied with the way your system is working, and you have the feeling that the people elected are not the best people. It may be true, but I would answer--

**RABI:** I didn't say that. I say they're the best under the circumstances.

[INTERPOSING VOICES]

**ARON:** You began by expressing that the people at the highest place in the political hierarchy should be the best. It was never the case. It has never been the case in any political system known in the world. It's not different today than what it was in the past.

The system to choose the best people to govern the other people has been discussed indefinitely through century, and no sure-good system has ever been found. And what you have described is not fundamentally different from what it was in other century.

It's more dangerous today because of the character of the scientific society. But there is nothing new in the fact that the people coming to the top in political conflict are not either the best in model terms or the best in intellectual terms. It was never the case. Why should it be so today? I'm afraid I will look skeptical or cynical, I'm afraid I am telling the fact, it has always been so.

**WIESNER:** No. The thing is now that the people who come to the top usually are very good in certain ways, in many ways, and usually they turn out to be also very intelligent.

**ARON:** [INAUDIBLE]

**WIESNER:** But the nature of our educational system is such at the moment that he has not been exposed to a well-rounded scientific education as part of his general education. I think this is what we're discussing, not that we expect him to be an outstanding scientist. I think you said earlier this would probably not be a good thing, and I am inclined to agree.

**RABI:** Only the Chinese had the-- had a system of examinations for the highest offices in the land. Unfortunately, the curriculum became too hard to pass.

[INTERPOSING VOICES]

**RABI:** Apparently it was an excellent system-- survived for hundreds and hundreds of years.

**ARON:** Do you think it was a good system?

**RABI:** More than the system of your country or mine, actually.

**ARON:** It's difficult to discuss because it was a fundamentally different society.

**MAN:** Quite.

**ARON:** It was a traditional society. We are living in societies looking towards the future, which is something absolutely new in history. It's difficult to know exactly what is the right people to govern the futurist society.

**WIESNER:** We're talking about two things, you see? We started talking about the general mass of the population-- all of us and how literate we should be. The fact is that our education system doesn't do very well in the other fields that we would like a man to be literate in.

Two, people are finding more and more students coming to college unable to write, having a very poor understanding of literature. And this is a deeper problem than just science.

**ARON:** And, no, I will not enter into this discussion because it's a purely American discussion. I don't know if you education system is as bad as that.

We are saying in France that our system is very bad, so I believe what is one of the permanent features of any education system-- to be bad in the eyes of the critics. So it's a degree of badness, probably.

**ZACHARIAS:** To someone with-- from your country, I would like to say that we do not have an educational system in this country, and it's very fortunate. We have an educational anarchy and it's lovely. Not only are there 50 states, but there are all sorts of everything.

And so we don't sink or swim even though on the average, we have [INAUDIBLE] our troubles.

**MAN:** There are raisins in the cake.

[LAUGHTER]

**COLLINGWOOD:** Well, doesn't in a very real way the future progress of science itself depend upon the understanding of the electorate? Science has to depend now on great infusions of government funds to support it. And how are the people going to vote those funds, vote for the expansion and development of science in the right directions, if they don't know anything about it?

**ASHLEY:** I do want to be a bit heretical about this. I still can't see, thinking of it in terms of my own country, a cab driver goes to the poll and he has to decide whether to the conservatives or labor. Is a knowledge of the second law of thermodynamics of any use to him? And by that, I mean generalized-- a knowledge of plants, and of botany, evolution. Is a knowledge of any of these things of have any use to him at that moment? I don't believe it is.

But I do think there are other-- the two other very good reasons for having this general core of scientific education. One is that we've lost in our country-- and I suspect in America it's the same, isn't it?-- any common core of culture you can assume-- in Russia, for instance, where every boy at school does everything-- you can assume that everybody's been through a 10-year school knows Ohm's Law, knows the second law of thermodynamics.

It may only be knowledge at the level of jargon, but at least the terms are familiar. And the other thing which I think this has produced is something which-- a reason I mentioned earlier. And that is it's helped to prevent the growing up a kind of high priesthood of science-- so science as a mystic who's got esoteric mysteries that nobody must understand.

I think that these are the two great values of a scientific education. And a third, that it's essential we should have a reservoir from which all our scientists come. And I feel in my country, where a great many people don't do science after the age of 14 or 15, we deprive ourselves of a great deal of that reservoir. People who might have become good scientists can't.

So I would say there are three good reasons for doing science and having it as a core of an education, but none of those reasons are anything to do with the responsibilities of a citizen in a democracy. And I still remain in opposition over that.

**ZACHARIAS:** Mr. Moderator, may I say that I don't really agree. I believe that something has been left out-- and I'm surprised that Sir Eric has-- and that is spirit and taste. And you know perfectly well that a man's, or a person's, taste it comes from an accumulation of all sorts of things.

Somehow or other, they've chosen to put you in front of the books, and I think that is in excellent taste. They could have put you in front of something much more drab, but they didn't. For this particular program, this is taste, and it's just on taste that the cab driver has to make up his mind in choosing. He sees people on television, and he gets that ring of not just sincerity, but acquired understanding that comes through a television screen, in the case of one man and not in the case of another.

**COLLINGWOOD:** A taste, a taste and interest, you would say, too, wouldn't you?

**ZACHARIAS:** What?

**COLLINGWOOD:** Interest. He's interested in these things, and therefore he's interested in the public discussion of them.

**ZACHARIAS:** Yes, but not in the detail. I want something underneath his--

**ARON:** What is, in your view, the relation between z state, which seems to me extremely important, and scientific education. Because, after all, that was the point of discussion.

**ZACHARIAS:** Yes. I think that a cab driver should-- or anyone-- should also have been exposed to Bach and boogie-woogie.

**RABI:** Without generalizing too much with Bach and boogie-woogie--

[LAUGHTER]

**RABI:** --just to to this subject. It is true, as a fact, that we get together, as scientists get together people of other scientists of different disciplines where you are a complete layman, nevertheless there's a certain rapport, which shows an underlying tradition. It's just this matter of taste I'm talking about.

Now, if you ask one to define taste, you wouldn't. You wouldn't ask one to define taste in cuisine, or in painting, or in literature. But there is a certain kind of sophistication about it, which one gets through an experience. It's one of those human faculties--

**ARON:** I agree with all that, but what I had in mind is that these tastes can be acquired by any sort of real culture. Any cultural man is able to have the taste of the human value.

[INTERPOSING VOICES]

**ZACHARIAS:** Of the culture of his time.

**RABI:** --of his culture. Exactly. And what we were talking about is putting this ingredient into this culture-- to make our cultural more homogeneous. And to that extent, I agree with Snow, very definitely-- that it's a problem for our age. In order to do that, perhaps the Russians have succeeded better than we. I don't know. We don't know enough about the Russians to say whether they have.

**COLLINGWOOD:** Dean Burchard, I interrupted you.

**BURCHARD:** But on far more pragmatic terms than this, I agree with all this idealism too, but Sir Eric's cab driver, supposing the only reason he has to vote for the liberal candidate-- let's take one who wouldn't be elected, the liberal candidate-- is because the conservative and the labour candidates have made appallingly bad decisions about science all this time.

And that's the real reason they should be thrown out. And if he has no reason, he's just going to be told this? Otherwise-- so it seems to me there is some chance for him to have, let's say, some intuition about this, as he already may have about some other things. How can he get that, except by this exposure. I think it's very practical, as well as very ideal.

**ZACHARIAS:** I think he also should be exposed to the ethics of a scientist. We, above any other profession, we are working with our honesty day in and day out. You just dare not, as a professional scientist, be anything but scrupulously honest. There's no other way. There is no other--

**ARON:** May I ask you one heretical word? I know many scientists which are extremely scrupulous in their scientific job and while not at all when it comes to politics. So the honesty in this professional job is no guarantee of general honesty. I will not quote in the example, but I have many in mind.

**ZACHARIAS:** But not many.

**BURCHARD:** Isn't it a little easier to be honest? I'm not talking about the ethics, no, I'm talking about the kind of evidence with which you deal.

**MAN:** It's easier to be honest in science-- [INTERPOSING VOICES]

**BURCHARD:** --fool yourself quite a lot honestly. It's much harder to fool-- I would guess, not being a scientist-- it's much harder to stay fooled, anyway.

**ARON:** They don't give the impression of having any difficulty with that [INAUDIBLE]

[LAUGHTER]

**MAN:** Oh, in other arts they do.

**RABI:** Again, I must remain silent on the examples, but I know many.

**COLLINGWOOD:** Well, gentlemen, there's one fact of science which we are immediately becoming aware of, and that is the speed at which time passes. And our time has just about passed, and I want to thank each of you-- Sir Eric, Dr. Rabi, Dean Burchard, Professor Zacharias, Professor Wiesner, and Monsieur Aron-- for talking on this extremely difficult subject, even about the law-- second law of thermodynamics, and talking so interestingly and illuminatingly.

And I want to thank President Stratton and Mrs. Stratton for letting us use their living room and use their guests. And I'm sure we all would like to congratulate them and MIT on this, their centennial celebration, which gets underway today. Thank you very much. Good afternoon.

**NARRATOR:** *ds equals dQ over t and YOU!* has been a special presentation of the CBS Television Network, saluting the Massachusetts Institute of Technology's centennial celebration, which begins this afternoon.

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