DRAFT

TRANSCRIBED REMARKS BY
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NATIONAL SCIENCE FOUNDATION
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...a change in the scale and we as a nation have not adjusted as yet to the demands imposed on us because of this change in the scale of the situation that we deal with.

The second reason as to why the situation now is more critical and more consequential than 30 years ago or so, is that for our country to maintain its international pre-eminence in the global economy, in science, in technology, in the arts, in the humanities, in all walks of life, we need to have a good supply of scientists and engineers coming through our educational systems. And some demographic data that I will share with you very shortly cause us to be alarmed about that situation.

The third reason, and in my judgment the most important of all reasons, is that we now live in a much more advanced scientific and technological society than we did 30 years ago or so. And it's the education in science and in technology of the nonspecialist that we have to pay attention to. We have to be concerned about the scientific literacy of the population at large. We need an educated citizenry that can distinguish between astrology and astronomy. We need an educated citizenry that understands the complex issues related to animal rights; we need a population that can deal successfully with pollution control situations; we need to have an enlightened citizenry

that understands the greenhouse effect; the consequences of the drought that we experienced this past summer, so they can understand the situation as it pertains to the ozone depletion and so on. We basically need to have a technologically literate, a scientifically literate, a mathematically literate, society. Otherwise, our pre-eminence around the world is threatened.

Let me give an analogy in this connection. This analogy comes from sports. Just as we have professional baseball players, hockey players, football players, basketball players, we also have sports fans. And without those fans the entire sports enterprise would be nothing. And you know that's not an exaggeration. So that's what we need. We need professional scientists, but we also need science fans. We need those science fans to be physically fit, if you will go along with my analogy; we need them not to be sitting only in the stands as spectators, but we need them to be participants in what goes on. We don't want them all to become scientists or engineers, mind you, but we just need to be sure that they are scientifically literate.

Let me offer another analogy because some people don't relate to the sports analogy too well. We need good orchestra players and we need audiences that appreciate what the performers are doing. And that's what the National Science Foundation is aiming at now, of increasing the flow of people who go into careers in science and engineering, as well as creating an atmosphere, a supporting atmosphere, for what the scientists and

engineers want to do. And we have to be very, very much aware about the tremendous changes that have taken place demographically.

By the year 2000, 80% of those who enter the workforce will be women and minorities. That's why we need to be sure that young females and young minorities have an excellent exposure to science and to mathematics in our school systems, as well as at our colleges and universities, because we need them to go into careers in science and technology; but we also need them to be, if they choose other careers, we need them to be appreciative of what science can do, of what technology can do.

(You said that it's the business of the National Science Foundation to increase the flow of young people going into the sciences and so forth. I guess I'm curious about what the National Science Foundation is doing to increase that flow.)

The National Science Foundation is an independent federal agency that reports directly to The White House, we do not report to a cabinet officer. We support basic research in the sciences and in engineering, as well as educational activities in science and in engineering. And we do this in a variety of ways. We make grants, basically to support graduate students who are pursuing advanced degrees in science and in engineering, we award fellowships. We support every year about 15,000 graduate students. About 10% of them have fellowships, the so-called NSF Graduate Fellowships. We support curriculum development activities at the undergraduate level. We support programs that

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deal with the revision of the calculus offerings. We are now focussing on the development of new undergraduate engineering curriculum projects. We are also interested in the laboratory offerings that colleges and universities have. And so we have a whole slew of activities at the undergraduate level.

But the bulk of our activities now, especially in science and engineering education, are at the precollege level, at the elementary level, at the middle school level and at the high school level. We have activities aimed at making sure that youngsters who have an interest in science are enabled to nurture that interest and to nurture the curiosity that they have. We have programs that are funded across the country whereby students at the middle school level and the high school level can partake in research experiences at various sites across the country. We support very strongly the teacher enhancement activities, in-service programs for high school teachers, middle school teachers, elementary school teachers, in the sciences and in mathematics. These activities, again, are carried out in every state in the union, mostly during the summer--4 - 6 week summer enrichment activities for teachers, with the emphasis on both increasing the level of competence of the teacher in the subject matters that they teach, but also we aim to improve the pedogogical skills that teachers have so that they can deliver the subject matters to their students.

We also have a great deal of emphasis on science education activities in nonclassroom settings. Our so-called Informal

Science Education Program supports a wide array of activities, including broadcast programs (both radio and television), as well as programs that are based at museums, science centers, zoos, botanical gardens, and so on.

And I want to tell you about a new exhibit that will open tomorrow at the Public Museum in Milwaukee. The Milwaukee Public Museum has a new exhibit called "Rain Forest," and it is an excellent exhibit that the NSF has put some funds in for supporting its establishment. In fact we, NSF, made a grant to the Milwaukee Public Museum for about $580,000 to help start that exhibit, which is aimed at making sure that youngsters, along with their parents and with their teachers, can learn about different biological concerns as they exist in a rain forest. The government of Costa Rica participated also in the development of that exhibit, so it's an example of the kinds of things that NSF tries to support.

I mentioned the broadcast media, let me give you two examples from television. The series 3-2-1 Contact is funded by the National Science Foundation and also private funders too. And the other, its twin series aimed at mathematics education, "Square One TV," is an activity that NSF continues to fund. So this is a very quick and brief overview of the kinds of things that we are doing.

(I guess I'm curious though, in spite all these efforts and the support that the National Science Foundation is giving to various projects, why we have relatively few students going into

science. jOur graduate schools are filled with foreign students. Presumably world population has gone up, it hasn't gone up solely in the United States. And yet we see very little, as far as I can tell, relatively very little interest or passion for going into the sciences. What's wrong?)

Well, you are using a very important question that has to do with complex societal issues that we have to face headon. In our country there are 16,000 school districts, over 3,000 colleges and universities. We have a diverse system of education, unlike other countries, or some other countries, where they have a monolithic approach to life and they do things in a somewhat different way than we do. This diversity in our educational systems is both a strength and a liability. It's a strength because it enable the schools districts and the colleges and universities to do the kinds of creative things that they choose to do. It's a liability because if we don't pay attention to how our students are doing and what they are getting in the classrooms we will then lose a great deal of talent that can help this country--a great deal of talent that go into science, can go into engineering which, as you pointed out right now, is not going in that direction.

It so happens that the number of 22-year olds in the country will continue to decrease through the year 2000. And typically, 4 percent of the population of 22-year olds get a bachelor's degree in the natural sciences and in engineering. So if the population is decreasing, then the number of people who will get

a B.S. degree in science and engineering will be going down. Furthermore, the number of people who will go on and get a Ph.D. degree in science and engineering will also be affected. It is estimated that by the year 2000 we will have a cumulative shortfall of about 430,000 holders of B.S. degrees in science, in mathematics, and in engineering, and about 8,000 Ph.D. degree holders in those same areas.

(What you're saying when you talk about shortfalls is that we really will need 430,000 more people than our society will have educated to fill positions in the sciences? Is that...)

That's exactly what I'm talking about. That's exactly right. And this happens at a time when 40% of faculty members across the country will be retiring, so the competition between academic institutions and industry for that talent will be increasing and that will help with one problem, namely, the salaries that faculty members that have, but then in terms of the cumulative shortfall, it's a very,very terrible situation that we have to deal with headon. And you were correct in saying that we have a large portion of our graduate students now coming from overseas. In engineering, for example, 40% of the students are from overseas. And there's nothing really wrong with that. In fact, it's the greatest tribute that we have to the quality of instruction that we have at our institutions of higher education. What's wrong is the number of U.S.-born students who do not go on to these careers in engineering and in science. And I myself support the position that says we ought to keep our shores open

to people who come from overseas, having come from overseas myself. I came in 1957 with my parents and my two sisters, and we have enjoyed the wonderful hospitality in this country and the tremendous opportunities that are available in this country. But I think what we ought to do is try to make those tremendous opportunities available also to U.S.-born students who have a great deal of interest in science and in mathematics. The have a great deal of curiosity at an early age. We need to nurture that curiosity instead of extinguishing that flame of interest that they have. One way of doing it is to emphasize the hands-on experiences that kids of all ages ought to have in their schooling, and by doing experiments, by satisfying the curiosity that we have.

You know, we ask questions all over the place. Why do the leaves change color in the fall? Why is the sky blue? Why is it that when the wind blows on a body of water, whether it's Lake Mindodo or Lake Michigan or a river, that we see what we call whitecaps? And is the color of the whitecaps in any way related to the color of the stuff that floats up in the sky? How does the microwave oven work? How does a digital watch work? Questions, questions, questions, all over the place. And what we need to do is nurture that curiosity at home, we need to do it also in the school setting, and we need to do it in nonclassroom settings outside the home. And that is what I feel very strongly about in terms of what must done at the local level and at the state level.

Because let me tell you, very frankly the talent in this country is as good as it is anywhere else around the world, despite the fact that on international comparison tests in science and in mathematics, the United States students do not do as well. But I am convinced that the talent is as good here as it is anywhere else in the world. Yet these studies tell us that there is something in our society, something in our educational systems, that we ought to be paying very special attention to. And what I'm suggesting is that we try to get the emphasis back on the hands-on experiences, on the nurturing of the curiosity, and to see to it that all segments of our population, not just the school people, but the parents and the business community, work together and insist on having good standards of achievements, good standards of performance, in the grade schools as well as in colleges and universities.

(Bassam Shakhashiri, we want to continue this conversation. We need to let stations and our network identify themselves. We'll be right back.)

(Station Break.)

(We're talking today with Bassam Shakhashiri. He is Assistant Director of the National Science Foundation for Science and Engineering Education. We're talking about science education in this country and if you'd like to join our conversation, you'll have a chance to do that. If you're in Madison or Milwaukee, dial 263-1890. If you're calling from any place else in Wisconsin, you can use our 800 number, 1-800-642-1234.

Bassam Shakhashiri, it looks to me as though you're trying to nurture my curiosity. You are surrounded by bottles and vials and styrofoam and so forth. What are you doing here in our studio?)

Well, we have a couple of interesting experiments that.. What I would like you to do is to describe to the audience what is going on here. Ok, just give us a play-by-play description and tell everyone what you are seeing. We'll see how that goes. Ok, I have a large glass here, it's a beaker, and you pick it up from here.

(He is taking a plastic bottle filled with clear liquid and pouring the liquid into the beaker.)

Margaret, it's clear and colorless. Right? They don't mean the same thing. Now what?

(Well, we have another clear and colorless liquid going into the same beaker. Little bubbles making their way to the top and a third plastic bottle of apparently clear and colorless liquid--it turned yellow as it went in and is now blue. Ah, it's turning clear and colorless again. What are you doing here Bassam Shakhashiri? Oh, it's getting yellow, blue. My goodness. We have a... Is this a magic trick? Or is there a timing worked into that beaker that causes the shifts in colors? It keeps repeating the cycle--clear and colorless, yellow and clear, and blue (a little opaque but clear I guess). Here come little bubbles to the top again, tiny bubbles. All right.)

You're doing an excellent job defining what is going on

here, and that's one thing that we want to try to emphasize in doing science. To emphasize the importance of making observations and describing what we observe in full sentences and in proper grammatical construction because communication skills are extremely important. We have to develop those skills so that we can do science. And this turns out to be an example from a set of reactions we call "oscillating chemical reactions." The color oscillates as you see from the clear and colorless then to the yellow and back to the blue color and the bubbles being released, those happen to be oxygen gas bubbles. This is a mixture of about 7 or 8 different chemicals, most of them are not found around the house. And one of them is especially, potentially hazardous--that's sulfuric acid, so we need to be careful about how we handle it. But the fascination of what you see and the description of what goes on here, and the curiosity that we all have trying to deal with the questions that arise from the curiosity is what science is all about. And this special set of chemicals again were prepared and mixed in the appropriate proportions because we understand what they are and how they interact with each other, but the fascination of the phenomena itself is what attracts the attention of new and others as well.

(Yes, I'd like to tell our audience that this beaker continues to change colors, it goes through that cycle again and again and again. It seems to me that maybe the blue phase is just a smidgen longer than the clear phase.)

That's an observation. In fact, that is exactly the cause and the duration of the blue color as part of that cycle of changes now is longer than it was before. And that's why people of all ages, not just youngsters, ask questions. How does that happen? What's in there? What's all this fizzing about? And so on. And that's part of the excitement that we have in science. You know, science isn't just something that happens at 11 o'clock on Monday morning in one classroom; science is all around us and this is a vehicle through which we can satisfy not only our intellectual curiosity, but also satisfy and fulfill our emotional needs because these are the kinds of things that human beings wonder about and try to find answers to and struggle with finding answers to.

(Let me play devil's advocate here. What you're doing here is performing a magic trick. Children love to come and watch magicians, but that doesn't mean that they all want to become magicians. You are entertaining, Bassam Shakhashiri, and in fact you are going to be doing a fun lecture here in Madison, "Once Upon a Christmas Cheery, in the Lab of Shakhashiri," Tuesday, December 6th. You're going to be performing. What makes you think that children are going to have their curiosity aroused rather than their need for entertainment satisfied? Having been entertained they can leave the lecture hall and never have to think about it again.)

But we all think about it again because we have this curiosity that, as I said before, needs to be nurtured rather

than extinguished. Let me make a distinction between magic and science. There's nothing wrong with having a magical trick attract someone's attention. But we have to provide the explanation for what's going on. We have to pursue questioning in terms of trying to understand what it is that is happening and many students, many kids that are not even students, ask questions. What are the chemicals? How long does this cycle last? Can you tell us what's going on now?

(Well, it's getting darker, darker and it doesn't seem to be showing any indication of lightening up again. In fact, that blue is looking kind of black.)

It's a deep blue color, now it's so deep it's black. And the oscillations have ceased after a short period of time. And so there are many, many questions that people ask about this. I don't believe in doing chemistry experiments or chemistry demonstrations only as magic tricks. I believe in having them be used as a point of departure for a discussion about the phenomenon that is in question about the beauty of pursuing that line of questioning and understanding what it is that one is talking about.

But let me tell you that this specific oscillating reaction was discovered in 1973 by two high school teachers. And a lot of people did research, high-powered research, for about nine years before they published papers in 1982 providing us with explanations as to what's going on. So the fascination of the different phenomenon that we encounter in life is what keeps us

curious and what we try to do is try to satisfy that curiosity.

Let me do one other experiment here and see if you can give us another play-by-play description here.

(All right. We have another clear, clean beaker and we have a plastic bottle with a blue liquid in it going into the beaker. The beaker looks about 3/4 full. We are now going to--is that dry ice?)

Yes, it is dry ice.

(Okay, little lumps of dry ice are being dropped into this blue liquid, which is now bubbling and steaming and making clouds that are floating above it. That isn't going to explode is it?)

No.

(Oh, it's now turning yellow.)

What is turning yellow?

(The bubbling liquid.)

THe liquid is turning...

(Not the steam, the clouds are still white.)

Margaret, tell me what this stuff is that is coming off the top up here. You've described it twice now in different ways.

(Well, it's kind of cottony foam, a fine, fine cloud-like material.)

It is. That is indeed what it is. It's actually condensed water vapor. It's mist, it's fog, it's clouds. It's not steam. Steam is an invisible gas we cannot see it. What this is is a reaction whereby dry ice, which is solid carbon dioxide, is bubbling into this liquid that was blue in color to begin with

because we had in it a substance called an indicator. In fact, an acid base indicator that tells us what the pH of the liquid was and when the carbon dioxide reacted combined with the liquid it formed carbonic acid which is the ingredient in all of carbonated beverages and the carbonic acid reacted with the liquid and changed color of the indicator telling us that the pH of the liquid has changed. At the same time, the carbon dioxide gas was escaping from the surface of the liquid and water droplets were condensing on the escaping carbon dioxide. You noticed the direction of flow of the fog. You tell us which direction...

(It's floating down the sides of the beaker towards the table that all of this is sitting on.)

It's moving downward, that's because carbon dioxide is heavier than air and the condensation is taking place on the carbon dioxide that is escaping. Now this is just another experiment that attracts a great deal of attention and makes us wonder about the different changes of color, the changes that are taking place and I'm sure you can hear the gas bubble very quickly.

(Yes. Well, Bassam Shakhashiri, we've got callers on the line waiting to talk with you, waiting... Is it safe to leave that experiment?)

Absolutely.

(Okay. Let's go to our telephones right now. Our first caller is from Reed Field. Go ahead please.)

Caller #1: Hello. I'd like to say a number of things. One, the topic you have today is one of the most important topics in our country today. And I'd like to recommend to you and all the listeners an article in Business Week magazine, Sept. 18, and it was entitled "Human Capitals, a Decline of the American Workforce." And in the last part of the presentation on the cover says "and as the economy comes to depend more and more on women and minorities we face a massive job of education and training and particularly in science, starting before kindergarten. [Excuse the dog.] But can we afford it? The answer is we have no choice." I am going to make a statement now that some listeners might consider rash, but I've thought about it. I believe that in order to descend and keep this country strong we have to cut our defense spending by at least 50% and put most of it over into a massive effort in education. Now people say you can't solve problems by throwing money at it, but we have a problem that I think is at a crisis level. We are not going to make it unless we begin to siphon off all the intelligent people from the third world and bring them in on green cards and that's going to be a disaster for the third world because we're taking away all the people that should be there dealing with their problems. And one other think, one of the reasons we have difficulty in school getting children to take the science courses is they tell, or they used to tell me, "Well if I take the entire courses I won't have a 5 grade point, my class ranking will go down, and I won't get a scholarship and Dad says

I have to get a scholarship." And so they tend to shy away from physics, and advanced biology and calculus and some of them, not all, but the ones that should be going in. We've got to begin to find ways to finance college education so that people aren't afraid to take the harder courses in high school. Well, that's it.

(Well, I appreciate your comments. Do you agree with all that Bassam Shakhashiri?)

Well, he said a lot. Let me also make the same comment about that article that was referred to. An excellent article. In fact, there is another writeup coming up in the November 14th issue of U.S. News and World Report that features the topic of our conversation this afternoon and also refers to the exhibit that I mentioned before in the Milwaukee Public Museum. I do feel very strongly that we, as a nation, have the capacity to deal with those complex issues that we are talking about. Not only in science, and in technology, but in all walks of life. We have the capacity. The question that I have is about our national will to deal with those issues. Do we have the determination? Do we have the urge, do we have the desire to act in a very forceful manner? You know, I'd like my answer to be "Yes, we've done it before." In the 60's the President said we will put a man on the moon before the end of the decade. There was a determination to do that. And I think the same thing can be done now. We have to improve the standards of excellence that we have at the local level and at the state level. We've got to

marshall the support of all segments of our society to emphasize the importance of excellence in education. We have to insist on those standards of achievement for all students. Now I do believe very strongly that students with their tremendous curiosity can be nurtured, can be advanced, and they will have good jobs. We have to continue to help them, help as parents and as members of the society, to pursue career goals. We have to insist on having good exposures to science and to mathematics in our school systems and we've got to do this by making sure that the teachers themselves are empowered to offer courses of high quality to challenge the students and to sustain their interest not only in science and in mathematics, but in all areas, because we do need lawyers, ...

...what I'm talking about here because its the quality of life in our society, the quality of life on the planet, that is in question and these are issues that require good determination, good resolve, and I feel that the resources are there, both the human resources are there, the talent is there; but we need to encourage it and we need to be insisting on having good standards of achievement in our schools, and in our colleges and universities.

(Our callers are suggesting that we should cut our military budget in two and pour that other half into science education. However much we might agree with that, it seems to me an unlikely prospect for the very near future. Given that, is there some reason to assume that we would do best with the limited resources

that we currently have by investing those resources in our most talented, or our most gifted. Yesterday, I had Arnold Ross on and he has been running a program for gifted and talented students in mathematics and the sciences for over 30 years. Does the National Science Foundation support projects like that?)

Oh yes. I know Professor Ross very well, and I know about his activities at Ohio State University and activities that have benefitted young mathematicians across the country. Yes, we support very strongly activities of that type. In fact, this past fiscal year we started a new program called Young Scholars aimed at middle school students and high school students who have an interest in science and mathematics to participate in summer activities and year-round activities at a variety of sites across the country. And the aim is to have these kids sustain their interest in science and in mathematics. And even if some of them don't sustain it, when they go on to other endeavors they would be part of the scientifically and mathematically literate society that I'm talking about. So yes, emphasizing gifted and talented students is a very important concern of the National Science Foundation, but let's quickly remember that the rest of the population also can benefit a great deal from good exposures to science and good exposures to mathematics. We should not allow the gap to widen between those subspecialities, or subspecialists in science and mathematics, and the rest of the population. That would be a very unhealthy situation to occur. What's really at stake here is the quality of life in our society. And if we care

enough about it, as I'm convinced we do, then we ought to be addressing these problems very, very vigorously, especially at the local level and at the state level where education is really controlled in this country. The federal government and the National SCience Foundation can do two things: We can call attention to the problems and make some suggestions, provide some alternatives that can be pursued and then we can also provide financial support for some model activities that can be put together and eventually, hopefully, emulated. I would be opposed to having a federal curriculum in science or in mathematics. I think that speaks against the nature of the effective democracy that we live in here. But I would be very, very strongly in favor of having states and school districts set good standards of excellence for their teachers and for their students. I would very strongly favor rewarding the teachers for the excellent job that they do. Make sure that they are paid well, make sure that they have good facilities for themselves and for their students to do experiments in. We should have courses in science, not courses about science. We need to have that kind of set of resources be marshalled at the state and local level to see to it that they are offering a high-quality education to our youth.

(Let me thank very much that Reed Field caller for being with us. Does that answer respond to your question?)

Caller #1: I'd like to say one last thing.

(Go ahead)

Caller #1: I think, Margaret, you and the public radio people do an awful lot to help the public understand this. Now this is going to sound critical, but so be it. _____ topics that we've heard over and over and go after this kind of topic, go to the Sept. 19th issue o Business Week, read it and start developing a whole set of programs along this line. It's far more critical than the American public understands. And certainly the last presidential campaign didn't shed any light on this most serious problem. The future of America depends on our economics and education more than it does on, at this point, national defense. Thank you.

(And thanks for joining us. I do do programs from time to time on science and I think you're right, probably I should do a lot more. We're moving now to a caller from White Hall, go ahead please.)

Caller #2: Hi. My question has a similar tone to your previous caller. In regard to national defense, it seems like a huge percentage of our scientists are siphoned off into the area of quote, unquote defense, and that's where too much of the money is for research and so forth, and so we're inadvertently fostering the very thing that you're saying, that the previous caller said we shouldn't, that even if we train scientists, we're putting them into the area of (and I always say quote, unquote defense because it seems more like war) instead of into you know, like basic science and research in other areas.

Well, we should be providing support as we do now for basic

research in the sciences and for education in the sciences and we provide that support for a complex set of reasons. Again, let me mention what some of them are. First, it's important for our national security to have a good supply of scientists and engineers coming through our educational system. That's essential. You take another issue which is very essential; it's also good for our economic security. We have a tremendous trade deficit now, we have a tremendous federal deficit, and the changes that must take place will depend on how our society deals with those advances in science, advances in technology, that have economic ramifications. But the third reason as to why we need to support basic research in the sciences and education in the sciences is that we live in a democracy and if this democracy is to be an effective one, as I firmly believe it is and can be made more so, we have to have not only the scientists and engineers doing their research, but we also have to have the public be scientifically literate and appreciative of the kinds of things that the scientists are doing, and also engaging in the debate that you and the previous caller have suggested in terms of the level of support that is placed into each of the different categories.

(White Hall caller, thanks. Thanks for being with us today. We need to let stations in our network identify themselves. We'll be right back.)

(Station break)

(You're listening to Wisconsin Public Radio. I'm Margaret

Andreason back with our guest today, Assistant Director for National Science Foundation for Science and Engineering Education, Bassam Shakhashiri. Dr. Shakhashiri is in our studio today; he is wearing a large "Science is fun" button. He has performed some experiments for us. And if you have questions about science education, give us a call. If you're in Madison or Milwaukee, you can reach us at 263-1890. And if you're calling from any place else in Wisconsin, dial 1-800-642-1234. Let me also remind you that Professor Shakhashiri will be doing a lecture which is open to the public on December 6th on some of the kinds of things he's been doing in our studio. "Once upon a Christmas Cheery, in the Lab of Shakhashiri." If you'd like to attend that lecture, which will take place in room 1351 at Farrington Daniels Chemistry Building at 7:30 on December 6th, you need to get a ticket. And you can get a free ticket by calling Pat Puccio. I need to give you her phone number. 262-3033. That's area code 608, 262-3033 and tell Pat Puccio that you'd like tickets for Professor Shakhashiri's lecture.)

I'm more than happy to have everyone come to the lecture, pending the availability of space. This is a lecture I've been doing especially around Christmastime since 1970 and it's a delight for me to come back to Madison to do it, especially in the past 4 1/2 years since I've been on assignment in Washington.

(Yes. There are people who want to talk with you Professor Shakhashiri. Let's go ow to our Madison caller. Go ahead please. Madison hello.)

Caller #3: Hi. When Professor Shakhashiri listed his questions, such as "why is the sky blue?" I couldn't answer any of them, nor my mother or preschoolers, and I wondered if he could give me resources or source books that I could use to educate myself along with my children?

That's an excellent question. I'm very glad that you've called and asked that. Let me first emphasize that the important thing is to field that question in a supportive way. To try to deal with that question not by saying well this is too complicated you will learn more about it when you take more science or you'll learn more about it when you go to college. The important thing is how to process that question because whomever is asking that question, especially about why is the sky blue or why do the leaves change color in the fall, they don't necessarily want the technical details that are involved. What they're really expressing is curiosity about something that they have encountered. Now, there are many sources of information of the type that you're asking about. Many books in the public library that one can go consult. I would urge those of you who have specific questions about science phenomena and science education in general to write to the Institute for Chemical Education at the University of Wisconsin in Madison. The address is: 1101 University Avenue, University of Wisconsin, Madison, Wisconsin, 53706, and the staff of the Institute for Chemical Education will be more than happy to provide specific references to various questions that you might have, not only in

the chemical area and chemistry, but in other scientific areas as well. The address again is 1101 University Avenue, Madison, Wisconsin, 53706. And you are writing to the Institute for Chemical Education.

(Does that answer your question, caller?)

Caller #3: Yes, thank you.

(Thanks a lot for being with us. We're moving next to a Junction City caller. It's your turn, go ahead please.)

Caller #4: Good afternoon. I have two points that I want to bring up. One is on teacher accountability and the next would be on funding for higher education in science. The first one, we happen to have a situation here in the small town where we have a nationally known, she got an award for her ability, this is a fourth grade teacher in science-she got some kind of award and you can see that she really gets kids excited. We happen to have a fourth grader that's in her class and she really you know, the kids really excel in her class and everything, but then in contrast, we have another, you know, the kids are sometimes split between other teachers and this is a math teacher who just doesn't know to work with kids at all and he's real inept and just doesn't know how to relate to kids. And I wonder, you know, are we going to have to depend on the teacher unions or, you know, salary incentives or what to weed out these inept teachers and encourage these... You know, I know that the private sector could easily lure this teacher away and, you know, we would lose a great asset because of salaries and whatever.

Yes. I think that we need to do everything we possibly can to be sure that the environment that all the teachers are in is a conducive environment to doing a good job. And if there are teachers who are turning kids off and so on, I think those teachers ought to be talked to and we ought to discuss with them why they're doing that and make them aware that this is the effect that they're having and then we ought to give them an opportunity to improve. If that does not happen, then the school board ought to take the appropriate action. I would emphasize the importance of acting in a positive way to try to take advantage of the talents of the teachers that we have now to make sure that they are given good salaries for the jobs, the excellent jobs, that they do. And if they don't do a real good job then they ought to be evaluated and they ought to told that they are not doing a good job and someone else should replace them. I would say that the business community in small areas, in big areas of the country has a special interest in the quality of education that goes on in that area, especial interest not only because we're talking about the quality of education of the children of the employees of that business community, but we're talking about the quality of education of the future customers of that business, small business or big business. And all of us in our society want to be able to make intelligent decisions and avoid having to make foolish decisions in our lives. And that's why we have to have these good standards of excellence in education, not only in science education, but in all of

education.

(Well now, Bassam Shakhashiri, I think it's fine to say that we need to encourage our best teachers and hope that we can drum our worst teachers out of the profession, but the fact is we have way to few science and math teachers across the country right now. You can afford to be picky in a school district about the marvelous qualities of a particular teacher if you've got 10 marvelous teachers to choose from. But I think also that my own education, I feel one of the reasons I never learned more about science was that I went to two high schools and the track coach taught math in the first highschool and the track coach taught chemistry in the second high school. And they were primarily coaches of athletic events, they were no teachers trained to do that. But I think that you can't raise the quality, insist on excellence unless you've got a pool to choose from.)

Well, I think the talent in this country of people who are apt to become teachers is there. There's no question about it. We have to be providing incentives for people to become teachers and to stay with the teaching profession. We've got to make sure that the environment that they're in, the teaching environment that they're in, is supportive. We need to be sure that the school boards supports the high quality standards that they want to put in place, they provide them with the academic facilities to do the right kinds of experiments. We've got to get this reinforcement from the parents that these things are important. Now you talked about teachers and the fact that you

had some people who may not have been qualified to teach the subject matters that you mentioned. This is a very serious problem. This is where local and state control should be exercised. This is where insistence on having competent teachers, committed teachers, be in the classroom. Now the problem is actually quite a bit more acute than that because in 30% of the high schools ion this country we do not offer a physics course. About 18% of the high schools in this country do not offer a chemistry course. And about 8% of the high schools in this country do not offer a biology course. One o the reasons is that they don't have the qualified teachers that are so essential to teach those subject matters and to communicate their excitement about science, their commitment to science, their fascination with science. And that's why we need to have a lot of concerted effort at the local level, at the state level, at the national level, to develop this national will that I talked about before to make sure that we tap the capacity that we have as a country to deal with these very complex societal issues.

(Junction City caller, thanks a lot for being with us. We have more callers and not a lot of time. Do you have a quick question for us. Go ahead.)

Caller #5: Well, I have one question I suppose would take a little bit more time. The question about defense budget came up a little earlier and I'm having a little trouble because my question is actually contrary to what I believe. Do you know of any businesses or companies that are getting involved in science

or science research in teaching? And if it's not companies, is that function really being taken on by the Defense Department? And, as part of literacy, wouldn't it be important for people to understand some of the relations which may be the political side of how research is done in this country under the heading of pure research. And I'll hang up and listen to your answer.

Well, okay, the answer to your first question is yes, industry in various parts of the country, big industry, small industry, big business companies, small business companies, are taking special interest in the quality of science and mathematics education nowadays. And the quality of education in general. And this is happening with the instigation of the National Science Foundation; it's happening on its own too. We have a program called Private Sector Partnership Program that brings together people from the private sector working with an institution of higher education and working with a school district trying to see to it that the quality of science and math offerings in that location is the best that it can be.

Now the second part of your question I believe dealt with how to..what was the second part that he asked about? Margaret do you remember?

(He was.. No. It seems to me that he was asking in effect if the defense industry doesn't to some extent sketch the agenda. In other words, we attract talent where we've got money.)

Yes, the defense contractors are quite interested in this problem of flow of personnel. And they are part of the business

companies, business concerns, that I'm talking about in terms of the interest that they have developed. You see we have a number of big ticket items now all across the country. Yesterday the future location of the Superconducting Super Collider was announced and that's going to require a great deal of technologically competent people, scientifically competent people, we have the mapping of the human genome that is a very, very big project that will require a great deal of scientific talent. We've got the Space Station and the concerns that we have and the fascination that we continue to have with space exploration that will require a great deal of personnel, both men and women, both members of the majority of the population and the minorities of the population to be involved in. So we've got these big national concerns that we must deal with successfully.

(Thanks to all of our callers and special thanks to our guest today, Assistant Director of the National Science foundation for Science and Engineering, Bassam Shakhashiri. Glad you have been able to be with us today.)

Thank you, I've enjoyed it.

(Thanks also to our production assistant, John Decker. Stay with us, I'm Margaret Andreaous.)