

THE EARLY DAYS OF SCIENCE EDUCATION IN UNESCO

by ALBERT V. BAEZ

My interest in UNESCO began in the very earliest days of UNESCO. I read an article in the New York Times, Sunday magazine section, that described the creation of a new United Nations Organization, called United Nations Educational, Scientific and Cultural Organization. It stressed the need for education as a basis for peace.

In fact, I remember reading the words from the Preamble to the Constitution of UNESCO: "Since wars begin in the minds of men, it is in the minds of men that the defences of peace must be constructed". Reading that had a very profound effect upon me because they stated what was a firm belief which I held, and which I had not been able to implement.

In fact, I was working then at the Cornell Aeronautical Laboratory in Buffalo, New York. I was there as a research physicist, but had been called upon to head up a new project on operations research. I didn't know what operations research was, and when I told that to my chief he said we don't either, but we hear it's important and that physicists are good at it, so we want to invite you to head up the Cornell Aeronautical Laboratory's Operations Research Group. Well, it turned out that operations research meant the operations of war, and so it threw me suddenly into a new field of activity which was different from what I was accustomed to, which was, namely, teaching - the teaching of mathematics and physics.

But it was challenging since the problem that had been tossed to Cornell was clear - it was a secret at that time of course - the defence of the U.S. fleet against air attack.

This opened up very interesting possibilities in the possible use of computers to simulate war activities and to estimate the probability of success of any given manoeuvre.

Well, I won't dwell on that. It seemed challenging, I accepted the job; but it was while I was doing that job that I read the article in the New York Times and I decided that, really, what I wanted to do was something in which science and technology were used for the benefit of mankind.

So I wrote a letter to UNESCO saying that I was interested in using the talents that I had in science and mathematics education, if I could be of any use. The first response from UNESCO was negative. They had no opening for me, and so I just sat back and waited. Actually, during that waiting period, I left Cornell Lab to go back to teaching, because I had made up my mind that that's where I belonged. So I accepted a full professorship in a small college, at the University of Redlands in Redlands, California. In part because they told me that I could take some time out to do research. Even though it was an undergraduate school, they were going to make it possible for me to do research with undergraduates. That was a very challenging idea and I accepted gladly.

I had been there only about a year when a letter came from UNESCO, inviting me to go on a mission for UNESCO. The Government of Iraq had requested of the United Nations assistance in setting up physics, chemistry and biology departments at the University College of Baghdad which was the forerunner of what would become the University of Baghdad.

This intrigued me and... I began discussing this matter with my family. At first, I thought that maybe I would just take a year off and go alone... but the offer was such that I could take my family if I wanted to. So after long discussions, we decided that we would go to Baghdad. The President of the University of Redlands, Dr George Armacost, was very co-operative. In spite of the fact that I had been at Redlands only one year, he was willing to let me go for a year, providing I promised that I would return and continue to build up the Physics Department at Redlands.

I will not tell the story of the Baghdad year, because Mrs Baez and I wrote it up in the form of a book, which is available and the title of it is *A year in Baghdad*, by Joan Baez Senior and Albert V. Baez. It was published by the John Daniel Publishing Company.

So, back to Redlands, to do research with undergraduates, and to tell the Baghdad story because I began giving lectures about our year in Baghdad. That did two things: it informed people about the existence of UNESCO and what it was trying to do to improve science education worldwide, and it reinforced my own beliefs in UNESCO as a tool for this change.

I will not take time out either to describe the years at Redlands during which I was able to do research with undergraduates, and actually to publish it.

For my doctoral thesis at Stanford, I had been fortunate in choosing a topic which was of great interest to me, and has since evolved into a very active field of research and investigation.

The field is now called X-Ray optics. I believe that that term, X-Ray optics, was first used in the title of my thesis, which was: *X-Ray optics: The design and construction of an X-Ray microscope*.

So I was fortunate in having done research in association with a pioneer, Paul Kirkpatrick and so the first publication on this subject bears the name of Kirkpatrick and Baez. And now forty years later, the instruments that are based on this principle are called Kirkpatrick and Baez X-Ray microscopes and X-Ray telescopes.

Back to the story of science education.

After six years at the University of Redlands, I was invited by Professor Zacharias of MIT to join a group which he had started, called the Physical Science Study Committee, PSSC. It is known in science education circles simply as PSSC. Professor Zacharias had felt the need for improving the teaching of high school physics in American schools. He and other physicists had started to look at the physics textbooks that were being used in American schools and found them wanting. They thought that something drastic had to be done to improve the teaching of physics, and they were driven in part by what they felt was a need to improve the backlog of physicists who would be needed in industry but also in the military. The military aspects were not stressed at all, either in the course, or in building the case for improvement of the teaching of physics. They simply said the physics textbooks are outmoded, we have to do something about it; the educators aren't doing anything about it and we, the physicists, had better take the lead. So, under the dynamic leadership of Professor Jerrold Zacharias of MIT, this group began to attract physicists and physics teachers from all over the country, and they took it upon themselves to decide in what order they would produce new materials. First came the physics textbooks. They felt that the new content ought to be spelled out, and that it need not follow the old patterns which had followed the classical order of starting with mechanics. They felt that it was not necessary to start with mechanics, which happened to be perhaps the most abstruse aspects of physics but rather to start with some other area of physics which might have more appeal and hence draw students into the way scientists and the way physicists think and act. So they started with the concept of waves. When Zacharias invited me to join, I found myself back at Stanford University. Professor Kirkpatrick had decided to take leave of absence and I was invited to come to Stanford as a visiting professor of physics. I had therefore

obtained leave of absence from Redlands after teaching there for six years, and here I was spending two years at Stanford, where I continued to teach physics and to continue my research in X-Ray optics. Then suddenly I got a letter of invitation from UNESCO in Paris, saying that they wanted to start a new activity in science education. And before long I was invited to come and participate in this new activity.

Now that meant that really I would not go back to Redlands. I had already been out of Redlands for two years, and here I was being asked to go to Paris to take on a job for quite a few years - the term was not specified. But the challenge was just too great for me. I had learned a lot about how curriculum reform in physics, or rather in science in general, could be done. I learned that one really had to start with the content, and that that had to be right, and that then one could consider the possibility of the additional tools that one would need for teaching. You would start with the textbook, you would produce laboratory materials, you produce a laboratory manual, you produce a manual for the teachers, and, what was of particular interest to Professor Zacharias, was films. And so, I had been invited to work on the film program. And in fact I was called the studio physicist and I practically lived in a studio and I learned a lot about film-making, and about how films could be used to improve the teaching of physics. So in the two years that I spent with the PSSC group, I picked up a lot of knowledge, and also some prejudices. I was prejudiced in favour of having reform in the hands of scientists rather than educators - that had been one of Zacharias' main themes. He kept saying: "It has to be done by scientists because they are the ones who know the content. You have to have the content straight and the methodology can follow".

There was some truth in what Zacharias was saying, but unfortunately he expressed it in rather arrogant ways, which put down the educators, and when the moment of truth came, after all the materials had been produced - after a period of a year or two - he found that, in order to get these new materials put into schools, he had to win over at least some of the educators, to give support.

Incidentally, the PSSC physics textbook had a worldwide influence. It was translated into many languages, including Russian, and it became the basis of reform in different countries.

Not all countries accepted the PSSC textbook as the basis of their teaching, but it did influence textbook writers and it did influence all those who were trying to teach physics in new ways all around the world.

UNESCO, P ARIS , 1961

In 1961, my family and I moved to Paris, so that I could become involved in the new activities in science education there. To my pleasant surprise, I found two individuals who had been instrumental in sending me to Baghdad almost ten years earlier: Mme Thérèse Grivet and Dr Malcolm Adiseshiah.

When I met Mme Grivet in the sixties, in Paris, she told me that she had been instrumental in sending me to Baghdad ten years earlier and Dr Malcolm Adiseshiah had now become Deputy Director General of UNESCO.

There were two other individuals, at UNESCO, who were influential in the direction that my Division took. One was Dr Hilliard Roderick who was a Deputy Director of Science, and Professor Victor Kovda who was the Director of the Science Department. In those days, science education was in the Science Department. In fact, it was because of that, that I was attracted to come to UNESCO. I was working on the assumptions that Zacharias had utilized at PSSC namely that scientists should be in charge of the science education process, so I accepted gladly when the invitation came from the Science Department. I felt that I could put into practice many of the things that I had learned with PSSC, and also avoid some of the mistakes that I thought we had made there. Before coming to Paris, I went to visit the heads of the other projects in the other sciences which had by now sprung

up: the chemistry project called "chemstudy", the biology project – there were two projects instead of one there – and the mathematics project that had begun. In other words, curriculum reform in the sciences and mathematics had begun to flourish in the United States, and I thought I'd better take advantage of what had been done there, and take these ideas with me to utilize as the basis of whatever activities I would develop at UNESCO.

PHYSICS, CHEMISTRY, BIOLOGY AND MATHEMATICS AT UNESCO

I was given the title of Director of the Division of Science Teaching at UNESCO and it was really my task to develop a program, I didn't have yet much of a staff, although Mme Grivet, the old pioneer, had been assigned to work with me. I came to the conclusion that, because of limitations of budget, we had better have some criteria for limiting what we would do. The limitations that came to mind were to consider what was fundamental and basic. My experience in the U.S. programs led me to think that physics, chemistry and biology were the basic sciences and that mathematics was, as Eric Temple Bell had once said, the "queen and handmaiden of science", so I figured that the Division of Science Teaching should have sections, with activities in physics, chemistry, biology and mathematics. So there would be four basic areas in which we would do some work. They were, fortunately, the areas in which work had been done in the United States, and subsequently in England and many other countries. So there was a backlog of material and man- and woman power out there which could be tapped as we were generating a program for UNESCO. Because of my own background, it seemed clear that I should take responsibility for developing the physics activities and so I began seeking help in developing chemistry and biology activities.

Once again, because of the prejudices and biases that I had picked up from the curriculum reform activities in the United States, I decided and later got the support of my director in this choice, namely to concentrate on secondary school science. Mme Grivet, who had sent me to Baghdad to work at the university level, continued to work in my division with the focus on university level science teaching activities. And the publications that came out at this level had been left in her charge. So now I was in search of individuals who would help me in what I had decided would be the basic areas in which we would work, namely the areas of the so-called basic sciences, physics, chemistry and biology.

Because of my own training, I decided that I would take responsibility for physics and that I would immediately be on the look-out for a chemist and a biologist. At about that time, it was rumoured that a fairly large sum had been set aside for new methods, techniques and approaches for teaching. No mention of science. But when I learned that money had been set aside for new activities, new types of activities and teaching, I immediately thought that the experience that I had had with PSSC and subsequently in my connections with other leaders of the curriculum reform movement in the United States could be useful, and that there already existed a lot of material and a lot of people who had worked in the development of these new materials who could be good advisors – at least – to UNESCO in the development of its programs. Just as the Nuffield Foundation in England had picked up the idea from PSSC and started a project for the improvement of the teaching of physics in the UK, similarly, other activities had sprung up in different parts of the world, and I thought that it was my task to find the best that had been done or was being done around the world and somehow utilize the talents of the people that had been involved in those to help us at UNESCO in developing a strong UNESCO program.

Although the wording of the proposed new activities within UNESCO included the concept of improvements in teaching, it didn't specify what those improvements might be nor what areas they would deal with. I saw the opportunity of getting assistance for my division by latching on to some of the funds that were being set aside for improvements in teaching. So I sat down and wrote the draft of a proposal for a pilot project on new methods, techniques and approaches in the teaching of physics in Latin America. In other words I had chosen the subject area, namely physics, the geographical area, namely Latin America because I spoke Spanish, and what I had in mind was a substantial program in which scientists and science professors from the region would help us generate a program that would develop new materials, new techniques for the teaching of that particular subject. Now... when I submitted this proposal to the Director-General, a meeting was held to discuss my proposal. I was asked to attend a Directors' meeting - I'm not sure that I was yet a Director at the time - but I was invited to state my proposals before the authorities of UNESCO at the time, so the Director-General, René Maheu was present, Malcolm Adiseshiah was present, and of course, all the other relevant people including the Director of the Department of Education and the Director of the Department of Science. And so I expounded my ideas for a project in Latin America that would help improve the teaching of physics in Latin American countries. The funds that had been set aside were substantial by the standards of those days; I think it was \$ 140,000 that had been set aside for a special project in new approaches, methods and techniques. So I proposed a project in the improvement of the teaching of physics in Latin America and I put down what I thought were the essentials of such a program. When I had finished my presentation, the Director-General asked for questions and comments. Mr Adiseshiah rose and said: "The funds that have been set aside for a new project are in the Education Department", and essentially he was saying that Baez was in the Science Department. The way I remember it, Mr Maheu said: "Yes, but I think that Baez knows what he is doing and I propose we allow him to use this money", or words to that effect.

Well, obviously, that was the beginning of a very strong support for me and for the Division of Science Teaching, but at the same time it generated problems because I had alienated the members of the Department of Education, because they felt that this new project rightly belonged to them. So the compromises that had to be made were of this nature: that if someone in the Education Department had the knowledge and the know-how that was needed in the running of our proposed project, that we would call upon the UNESCO staff member who had those responsibilities. For example, in the audiovisual field, there was someone in the Education Department and I was supposed to consult with him very closely on whatever activities we developed along those lines. There was a new area that involved programmed learning - programmed instruction was something very new - and since we were talking about new activities, it was clear that we would have to utilize the person who was in charge of programmed learning in the Education Department. Fortunately I knew most of these people in the Education Department and I had developed fairly good personal relationships with many of them and therefore, they did not take my proposals as a threat and we actually found ways to collaborate. The point is that we got the green light to start something new and very important from the point of view of education, I thought: new approaches, methods and techniques in the teaching of science at UNESCO.

THE PHYSICS PILOT PROJECT IN LATIN AMERICA

I got the green light for a project on physics for Latin America and I immediately began my search of the people who might run it. We needed a Director and an Assistant Director. My travels took me to many countries in Latin America, to inform people about what we wished to do and also to seek individuals who might participate and in particular who might be the Director and the Assistant

Director. When I asked this question in several different countries, one name came up more than once, and that was Dr Nahum Joel of Chile. So I made up my mind that I had to go to Chile to meet this man, which I did. That must have been around 1962, and when I did meet Nahum Joel, I think there was a mutual attraction between us which was to last many, many years. In any case, I discussed the matter with Joel, who said he didn't know whether he could be relieved of his duties at the university, but that the idea was interesting to him. As time went on, ideas about what could be done in such a project began to develop with my staff at UNESCO. At the same time, we had been adding members to the staff of our Division and before too long we had a chemist who was Dr Robert Maybury from the United States, and a biologist, a Mr Wroblewski, from Poland. So it looked as if, within the House, I would be in charge of physics, chemistry would be in the hands of Maybury, and the biology program would be in the hands of Wroblewski. So, back now to the physics project. We had to find, as I said, the Director, and we found some compromises were made probably on the basis of political balance, and other factors that enter into these decisions, but Bergvall, a Swede, was chosen as Director of the Project and Nahum Joel was chosen as Assistant-Director, and before long we were planning what the actual content, what the actual approach would be. Since the emphasis had to be on new techniques and materials, we had to decide what would happen in this project. Well, we decided that it should last a year, that we should invite participants from all the Latin American countries, and that we should emphasize the creation of text materials, but in one year we knew we could not do a whole textbook in physics, so we chose an area of physics, namely the physics of light, which again showed my preferences because I thought I knew something about that. So we chose that chunk of physics, namely the physics of light, to be the subject matter, and decided we were going to produce films, that we were going to produce programmed instruction materials, and that we would produce, perhaps, some television materials. So we decided, by having meetings at UNESCO House and meetings in Latin America, more or less the structure and the outline of what was going to happen in this pilot project.

THE USE OF FILMS IN SCIENCE TEACHING

Now, remember that our charge was to find what was new as regards methods, techniques and approaches in teaching, and certainly, one of the things that was new at that time was the use of films that fitted a special new projector which the Technicolor company had put out. It had this feature that the films were of short duration, about 4 minutes, that they were in continuous loops, meaning that when you projected a film, when it came to the end, it was ready to start at the beginning again. It was a continuous loop; and the teacher could easily stop the projector, and start it again, by pressing a button, so it had some of the features which are now utilized in video. We were far from video at that time, and yet this was the beginning of some of the concepts. The notion that they should be short had already been explored in many different parts of the world. There had been recognition of the fact that long films really did not belong in the classroom. So we decided that in the physics pilot project we would produce a set of film loops, and that each participant to the pilot project would be given a projector of this type to take back home for utilizing the film.

Incidentally, there were many decisions that had to be made and no clear-cut criteria in many cases on how to make these decisions. For example, what country would be chosen as the headquarters for the pilot project for one year? It turns out that we ended up in Sao Paulo, Brazil, and you might immediately ask how come Brazil was chosen when the language of most of the other countries is Spanish.

Again, this illustrates how decisions are often guided by concepts that you had not taken into account. It turns out that there had been a meeting in UNESCO House in Paris, where a group of educators from many parts of the world had come. One of them was a woman from Brazil, Maria Julieta Ormastroni, and when she heard about it she became very excited. She was in UNESCO House for a conference and she came up to my office and said: "This project has to be in Brazil". And I said: "Well, here's what we'll need", so I outlined what we needed in terms of space and other facilities, and she said: "I can get all of those for you in Brazil". In fact, she wanted me to come to Brazil to visit so that I could see that they did indeed have the facilities that we needed. I told her that I didn't have money in my budget to make that trip, and she said: "I'll find the money". So, indeed, they bought a ticket for me, they invited me to come to Brazil, and they showed me indeed that they had facilities in Sao Paulo. It actually happened to be in the medical school, but there was an enthusiast, Doctor Isaias Raw, who had himself started some curriculum reform projects, quite independently of UNESCO. And so they welcomed us there. They said: "Whatever you produce in Spanish can be produced in Portuguese almost simultaneously, and we have the television station if you want", and they did indeed make everything available that we thought was necessary. So we decided to go to Brazil.

THE CONSTRUCTION OF LABORATORY KITS

I almost forgot to mention that the construction of inexpensive laboratory materials in the form of kits which the teacher could utilize, was one of the important aspects of our work. It was clear to everyone that one of the weaknesses of science education, not only in Latin America but around the world, was that students did not have access to laboratory materials. So we decided that we would invent the materials, that they would be of low-cost, and that they would be of the type that could be repaired if things went wrong, and that they would be boxed separately so that any given topic would be covered by a kit which is in a box, so that you could put all the materials back into that box at the end of the laboratory hour. So a lot of ingenuity went into the invention of the experiments and of the materials that were needed to do those experiments and so a set of eight kits were invented, manufactured, produced during the pilot project. All of these materials were interlinked with one another, so that the lab material supplemented the text as did the films. They were an integrated package of teaching aids and they bore the stamp of the UNESCO pilot project. So we ended up with about 8 kits, 12 short films and about 4 books, in programmed instruction form, which were teacher's manuals for the use of the films. They also produced one long 16 mm film, the title of it was "Light, is it a particle or a wave?".

Well, it is clear that I cannot go into chemistry and biology and mathematics in as much detail. Suffice it to say that because of the success of the physics pilot project, we were able to find funding in subsequent biennia for a pilot project on chemistry in Asia, a pilot project on biology in Africa, and then one on mathematics in the Arab States. The actual development of these projects turned out to be somewhat different from the approach we used in Latin America, but they were adapted to the needs of the region by the people who were chosen to run them.

CONCLUSION

The things that I remember mainly then were the early days of the pilot project, the early days of some of the publications that came out, the early days of the creation of an integrated science activity, the early days of environmental concern, which eventually generated a whole new activity within UNESCO. These were the pioneering days. At a certain point in our trajectory the concept of

integrated science came up, and Sheila Haggis was hired initially just as a temporary helper, but it became clear from the professional way in which she handled that project, that she would be an asset as a member of our Division. There are still people around who can tell some of the early anecdotes about them, or who can fill in with solid details which I have forgotten: Joel, Maybury, Harold Foecke.

BIOGRAPHY OF THE AUTHOR

ALBERT V. BAEZ

Research physicist at the Cornell Aeronautical Laboratory in Buffalo, New York, Albert V. Baez spent six years at the University of Redlands, California, and two years at Stanford, teaching physics and making research on X-ray optics.

In 1960, on mission for UNESCO, he spent one year in Baghdad to set up physics, chemistry and biology departments at the University College of Baghdad. Directly involved in a USA project for the improvement of physics education in secondary schools, he was entrusted in 1961 with the leadership of the Division of Science Teaching within the Department of Natural Sciences of UNESCO. He remained Director of this Division until 1967. Mr Albert V. Baez is now President of Vivamos Mejor/USA.