A Conversation with Esther Seiden

Ester Samuel-Cahn

Abstract. Esther Seiden was born in 1908 in West Galicia, Poland. She studied mathematics at the Universities of Krakow, Wilno and Warsaw and obtained a Magister of Philosophy degree. She moved to Palestine in 1935, where she came to Statistics by chance. She obtained her doctorate in statistics in 1949 from the University of California at Berkeley, under the guidance of Professor Jerzy Neyman. She has held positions at many American universities, notably the University of Buffalo, the University of Chicago, Howard University, The American University and Northwestern University. In 1960 she accepted a permanent faculty position at Michigan State University, where she stayed until her retirement in 1978. She has visited many interesting places, such as India, Russia, Turkey and Cyprus, being involved in teaching and research. Her main research interests are optimal design of experiments and finite geometries. As of 1979 she resides in Jerusalem, Israel, where she still is active in teaching and research. The following interview took place during July 1991, at the Mount Scopus campus of the Hebrew University.

THE EARLY YEARS: LIFE AND STUDIES IN POLAND

Samuel-Cahn: Hi, Esther; it is nice of you to agree to give us an interview. Can you tell us about your early childhood memories?

Seiden: I was born in a little town in West Galicia, Poland, which was at that time part of the Austro-Hungarian monarchy. My family belonged economically to the upper middle class due especially to the successful business activities of my grandfather. My father received a traditional Jewish education. However, as was customary in that part of Poland, he attended the Government grade school available in the little town. He continued his education as an autodidact and was well versed in German and Polish literature. As an adult he joined the Zionist movement, and in fact he was the first Zionist born in that little town. My father read and discussed with friends and his younger brothers the writings of the Jewish counterpart of the parent European Enlightenment movement. He kept reading current Hebrew journals and literature. When I left home, I used to correspond with him in Hebrew. His hobby was law, and he studied Polish government publications pertaining to law. When there was a need to defend my grandfather's business against discriminatory threats, he wrote the appeals to the Court of Appeals. Shortly after the start of the First World War, he was drafted into the Austro-

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Hungarian army. He served as an officer in the air force base near Vienna until the end of the war. While he was serving in the army, he asked my mother to start teaching me and my older and younger sisters Hebrew as a spoken language.

Samuel-Cahn: How was it that your mother knew Hebrew?

Seiden: My mother was what would nowadays be called a forerunner of the feminist movement. She insisted on an active participation in discussions of the Zionist movement, which often were based on reading the modern Hebrew literature. She learned Hebrew with the help of my father and her brothers-in-law.

Samuel-Cahn: So what language did you speak as a child?

Seiden: Polish. My parents believed that the first language should be the language of the country one lived in. They considered Yiddish as a language of the Diaspora and thought that the next generation should be detached from it.

Samuel-Cahn: Was there compulsory elementary schooling at that time?

Seiden: I imagine that there was. Every Jewish child in the town attended the small public elementary school, which went up to the sixth grade.

Samuel-Cahn: So you finished the sixth grade in that school?

Seiden: No. Since our parents planned higher education for their children, we started following the gymnasium educational program after finishing the fourth grade. But there was no gymnasium in our city. There were some young people – teachers and students –

FIG. 1. *Esther Seiden is on the left at age 4, with her older and younger sisters, 1912.*

FIG. 2. *Esther Seiden, on the right, with mother and sisters while father is in the army, 1916.*

whom my father used to hire as tutors for me and my sisters.

Samuel-Cahn: When did you first discover that you had a talent for mathematics?

Seiden: I don't know. I just was interested in mathematics. I studied on my own, and once a year I had to go to a bigger city to take exams in order to get promoted to the next grade. Mathematics was the subject which was the easiest for me to understand, and I found it fascinating. The other subjects got me confused. I didn't like history; I wasn't interested in the dates of wars, and between whom. I think that my eyes weren't very good, so I didn't read fast. For mathematics, I didn't have to read, and the subject seemed to me to be on a very solid ground.

Samuel-Cahn: How many years did you continue with private tutoring?

Seiden: Until the last grade of high school. It was hard to pass matriculation exams without attending school, so for the last year of high school my father sent me to a Zionist Organization–sponsored Gymnasium in Krakow, which also had matriculation in Hebrew, preceding the general matriculation. If one failed the Hebrew matriculation, one lost a year of studies, since the school made the Hebrew matriculation a prerequisite to the government matriculation.

Samuel-Cahn: When did you matriculate?

Seiden: 1927.

Samuel-Cahn: And then did you decide to study at the university right away?

Seiden: Yes, I wanted to study mathematics. My father was not happy about it. He felt that mathematics was not a suitable subject for girls. I think that he would have preferred for me to choose law – although this was also considered a subject not proper for girls. He tried to convince me not to study mathematics, but I insisted.

Samuel-Cahn: Were there many girls studying mathematics?

Seiden: In our class there were two. Altogether there were very few girls.

Samuel-Cahn: And in other subjects?

Seiden: In the language departments, the majority of students were women.

Samuel-Cahn: Can you tell us about your university education?

Seiden: I first started at the University of Krakow. But I wanted to support myself. During the war, my father's resources were almost entirely depleted. His

FIG. 3. *Matriculation exam in Hebrew, 1927. Esther Seiden is in the second row from the top, fifth from left.*

income before the war was based on cash investments, stocks and Government savings bonds. These devalued during the war, and my father never fully recovered from the financial crisis. I had an uncle in Wilno (now Vilnius), who was a teacher of mathematics in a Jewish high school, and through him I had no problem getting tutoring work in Hebrew and mathematics, so I left Krakow and went to the Stefan Batory University in Wilno.

Samuel-Cahn: Did you encounter any special difficulties because of your Jewish origin?

Seiden: No, not at all. The three years of my studies in Wilno were very happy years. My major was mathematics with a minor in physics. There was also a required course in philosophy, which for mathematicians emphasized logic. The program included an elective course from among astronomy, geology and an extended course in mathematical logic. I was the first student who chose mathematical logic. I received special attention from the examiner, who was a professor of philosophy. I participated actively in his philosophy seminar, which was not included in the required curriculum.

Samuel-Cahn: What made you move to Palestine?

Seiden: I was very happy in Poland. I did not encounter any personal discrimination. Nevertheless, I felt that being Jewish I could not be a full-fledged citizen. Since I was brought up in a Zionist home, I felt strongly that only Palestine could provide me with such a status. In theory my father didn't object to my going to Palestine, but in practice he didn't want to lose a daughter.

Samuel-Cahn: But you weren't staying at home at that time anyway?

Seiden: No, but still I was in Poland, and coming home for vacations. My sister was studying agriculture, and my father was very unhappy about it, because she belonged to an organization where they prepared themselves to emigrate to Palestine. I did not want to give up mathematics, but going to Palestine was always in the back of my mind. I knew I would get there some day, but how I was not sure. So I continued my study of mathematics in Wilno. The only possibility of working, after completing a Master's degree in mathematics, was to teach mathematics in high school. But to get such a position in a university city was very

FIG. 4. *Esther Seiden with sisters and father, 1930. Esther is on the left, standing.*

difficult, since there was a lot of competition. The only choice was to go to a small town and to get detached from the university. During my last year, I had a fellowship at the university. My professor asked me what future plans I had. I told him that I didn't know, but thought that I would have to go to a small town to teach mathematics. He said, "No, that is not a choice for you. Give me your papers, and I will recommend to the board of education in Wilno that they give you a position here." A high school position usually enabled one to continue studies at the university.

Samuel-Cahn: Had you completed your Magister of Philosophy degree by then?

Seiden: Yes, there was no degree below a Magister of Philosophy degree at that time. This degree enabled you to teach in a high school. Then, after two years, one had to pass an exam in various subjects, such as philosophy, psychology and education, to get tenured. My professor was unsuccessful in getting me a job in Wilno. Then another professor intervened. He said there was no rule forcing me to terminate my studies at that stage, and there was no law that one could obtain a fellowship before finishing the Master's degree and not afterwards. So they decided to give me a fellowship for another year. That was the year when the disturbances started in the university. The Polish students objected to the Jewish students studying at the university. They wanted to make a law that all Jews sit at the left side of the classroom. And then, in some subjects, not in mathematics, they did not allow any Jewish students. The Polish students started riots. They went from one part of the campus to another. In between, there was a Jewish neighborhood. So they started to throw stones. And the Wilno Jews were of a different type than the Galician and Austrian Jews. They were also very easy to get excited, and they reacted, and also started to throw stones. So stones were thrown from both sides. On the first day of riots,

a Polish student was hit on his head, and he died. So the university was closed. I was sitting in the philosophy seminar, because we had a room there for students, where I was reading. My professor was going through, and said, "Everything could be settled, but there is blood between us." That hit me very hard, because how could such a person fail to understand that when people are throwing stones it can also hit a Polish student? Anyhow, at that time, one of the professors said to me, "We know that you want to go to the University of Warsaw, since you are interested in Mathematical Logic. Why don't we ask that your fellowship be given to you in a lump sum. Then you can go for a year to Warsaw."

Samuel-Cahn: With whom did you want to study in Warsaw?

Seiden: With Alfred Tarski and Stanislaw Leśniewski. The leading person in Mathematical Logic was Leśniewski. He is not very well known. He was a perfectionist and hesitated about publishing his results. I attended his lectures and enjoyed them greatly. He was a brilliant researcher.

Samuel-Cahn: Was Tarski his student?

Seiden: Yes, Tarski got his degree under Leśniewski.

Samuel-Cahn: Did you move to Warsaw and study under Tarski?

Seiden: Yes, I did. And the year passed very fast. Then I thought, "What shall I do next?" Several professors recommended that I contact various people; one of these, who was a converted Jew, said, "You are Jewish and in Warsaw there are government schools for Jewish children; there you can get a position." There were also Polish teachers at such schools, but they were not too happy to teach there because the day off was Saturday, not Sunday. I filed an application with the Education Board in Warsaw and got a job as a substitute teacher. The reason for my success was the university prestige. A recommendation from university circles carried a lot of weight. The principal of the school was Jewish. She was not happy seeing me, since she needed an experienced teacher for the first grade!

Samuel-Cahn: Did you end up teaching first grade?

Seiden: Yes, I did. I taught all subjects, and in addition to the first grade I taught some classes in mathematics to higher grades. But I was responsible for the first grade with 65 kids.

Samuel-Cahn: 65 kids with one teacher?

Seiden: Yes. Because by that time elementary school education was compulsory, and there were more children than classrooms and teachers! We had to justify each case of a child not promoted to the next grade, because that caused extra expenses. So the principal was very unhappy. But there were other teachers with a university education. (It was very rare for a Jewish girl to have attended teacher's college, so most of them had a Master's degree from a university.) They tried

FIG. 5. *Esther Seiden in Warsaw, 1934.*

FIG. 6. *Esther Seiden (top row, far right) with her elementary school class in Warsaw, 1932.*

to help me. In fact, I enjoyed this teaching more than any other teaching I did in my life—because I think every child in the first grade understands that learning to read and write is useful, and that one has to do it. So you teach them something which they want to know. That does not happen when you teach mathematics when it is compulsory and the students are not interested.

Samuel-Cahn: How long were you an elementary school teacher?

Seiden: Two years. From 1932 to 1934. My contract was extended for a third year. But at the end of the second year, I decided to move to Palestine. I was working on the completeness of a system of axioms in plane geometry. It became clear to me that my chances to obtain meaningful results within the near future were very slim. So it seemed reasonable to think about realizing my plan to move to Palestine and, if possible, to continue my research there. In fact, the only way I could get there was to be admitted as a candidate for a Ph.D. degree at Hebrew University.

Samuel-Cahn: Couldn't you just buy a ticket and go?

Seiden: No, I needed a certificate. I was not a member of any Zionist organization, and certificates were given only to members of such organizations. There was an agreement between Hebrew University and the British government (who held the Mandate of Palestine) by which whoever was admitted to the Hebrew University got a certificate. A certificate was an immigration visa. These certificates were deducted from the general "quota" of allowable immigrants. Therefore, the university did not want to give a certificate to an individual who wanted it as an excuse to enter Palestine, but wanted only those who intended to become serious students. There was an organization in War-
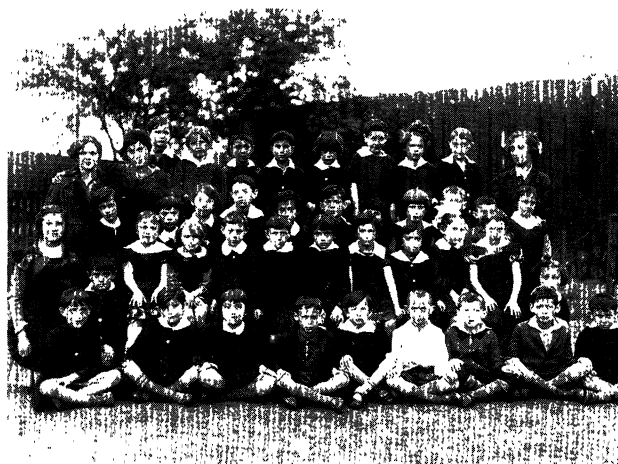
saw, Polish Friends of the Hebrew University, that suggested that I get a recommendation from a professor in Warsaw and from someone in Wilno. Tarski gave me a recommendation, and from Wilno I got a recommendation from the professor who earlier had said "there is blood between us."

Samuel-Cahn: So he was willing to write you a letter?

Seiden: Yes, and not only that! When I left, he congratulated me, and he said in German, "You are going to the land of oranges." I wish to add that during the Second World War he saved several Jewish families from the Holocaust by giving them a shelter on his farm. There is a tree in his honor on the Avenue of the Righteous of the World, in Jerusalem. He made an effort to find me after the war, and I kept in touch with him until his death in the late seventies. He belonged to a group in Poland who wished that the Jews would disappear, but not the way they did.

LIFE IN PALESTINE

Samuel-Cahn: What year did you come to Palestine?
Seiden: 1935.
Samuel-Cahn: Did you go to the Hebrew University?
Seiden: Yes, I came and presented myself to Professor Abraham Halevi Fraenkel. He was very nice to me. I attended and participated actively in his seminar. There was some money one had to pay in order to guarantee that one would be a student. After one year of study, one could get the money back. I got this money back, and, not only that, but Professor Fraenkel was very interested in helping me, so when he saw, in 1936, that I wasn't doing anything in mathematics, he thought it was because of my financial condition, and he suggested that I apply for help to the University

Women Association. The real reason was that I lost interest in mathematics because of the political situation and disturbances.

Samuel-Cahn: Were there many women studying for a Ph.D. in mathematics at the university then?

Seiden: No, very few. None in my situation.

Samuel-Cahn: Was the Haganah the reason you left your studies?

Seiden: Yes, one of the reasons. I came to Fraenkel's seminar on the Mount Scopus Campus, and the son of Professor Michael Fekete (a famous mathematics professor) was also studying mathematics. I entered the class, and I saw him walking around the campus. I understood what he was doing, because I knew about the Haganah even in Poland. (The Haganah was a Jewish self-defense semi-military organization, which was considered illegal by the British. At the termination of the British Mandate in 1948, it became a main part of the Israel Defense Force.) But I didn't want to join them; I wasn't militarily inclined. I thought it didn't interest me. But when I saw that every night there was shooting in Jerusalem, I thought, "People are defending Jerusalem, so why should I be outside?"

Samuel-Cahn: Who was shooting?

Seiden: The Arabs were attacking the neighborhoods in Jerusalem, so the shots were from the Arabs, and the young Jews were defending.

Samuel-Cahn: And the English didn't do anything?

Seiden: The English didn't intervene. I thought that Jerusalem had to be defended and that I should do my share. I went there. They didn't ask me any questions, but told me to help in the kitchen. I worked there for two months! It is very hard to keep a voluntary army active when there is nothing to do. And suddenly when something starts, there are no people! The kitchen was feeding the many young people who took time off work to carry out the orders of the Haganah, and the Jewish Agency gave the money to feed them. After two months they called me in. There was an investigation, and they told me, "It is very easy to get in, but much harder to get out because one knows too much! So now you have to decide whether you want to stay or leave!"

Samuel-Cahn: How did you make a living?

Seiden: I was a teacher. I came to Palestine in March and took care of some children until September, when I got a position as a mathematics teacher in a private high school. All the Haganah work was on a voluntary basis.

Samuel-Cahn: How long were you a high school teacher?

Seiden: Five years. And I didn't like it. When I first came, I went to the Bureau of Jewish Education and told them that I have a Hebrew matriculation, that I had been an elementary school teacher in Poland and that I want a similar position here. But they said that

FIG. 7. *Esther Seiden with her gymnasium students at Sokolov Gymnasium, Jerusalem. Esther is third from left, middle row.*

I didn't have the qualifications; I had qualifications only to teach in high school.

Samuel-Cahn: Did you continue your studies?

Seiden: Well, I tried to go to some lectures, but I didn't do it seriously. I read some papers, I got some reprints from Warsaw and I read the papers of Tarski and Adolf Lindenbaum.

Samuel-Cahn: When did you switch from mathematics to statistics?

Seiden: When the Second World War started in 1940, I thought, "I don't like the high school teaching; I also don't want to volunteer to the British army (as quite a few Jewish women did) because I don't like it." In the meantime, I was a Commander in the Haganah. So, I figured, "If the Haganah orders me to join the British Army, I will obey orders." But they didn't. Then I worked as a secretary for the Mogen David Adom (corresponding to the Red Cross), which was also a cover for the Haganah. This was useful to the Haganah. I worked for very little money and did my best. When the war was ending, 1944–1945, I thought I had to switch work to something where I could use my mathematics. I didn't like high school teaching, and I never thought of university teaching, so what should I do? One day a woman came to the Mogen David Adom to find out her blood type. While she was waiting, we got to talking. She worked at the British Government Bureau of Statistics, and I asked her about the possibility of getting a job there. She said they were just planning a Census of Industry, and the person in charge was looking for mathematicians. He already hired one, and maybe I could also get a job. So I got an interview with Dr. Pinchas Hamburger, and he gave me the position. I told him I needed time to get released from my present job, and he was willing to wait. He said they were just sending out the questionnaires, and until they were returned there was nothing to

do. At first, the Mogen David Adom objected to my leaving, but I promised to continue on a voluntary basis, and things were settled. So I began my work at the Government Department of Statistics. It wasn't using statistics, but it was very amusing! The questionnaires were coming back. Part of the industry was working for the government, such as the jam and can industries. And to ask them to give different data to the Statistics Department than to other government departments was very difficult. So when we began to examine the answers on the questionnaires, we saw that the answers couldn't be true. We wrote letters to the factories, asking questions. But either the answers weren't returned, or they were returned but were obviously not true. I took a questionnaire from one factory, which I knew had no reason to lie. From it I learned how much raw material was needed, etc., so that I knew what was going on. A manager of a kibbutz jam factory was aware of the problem and came to our office to discuss the difficulties in filling in the questionnaire. I was lucky to help him. We found a way to solve the problem. A manager of another kibbutz factory discussed the problem with him, and he advised him to ask me to visit the factory. Dr. Hamburger told me that his plan was that I should not participate in field work, but he yielded to the request. Moreover, he asked me to stop on my way in Tel Aviv to discuss with an owner of a heavy industry factory his questionnaire. When I called on the owner of this factory, I was told the problem had to be discussed with his accountant, who was available only after 8 o'clock in the evening. He was very surprised to hear that this was OK with me. The discussions with industry people, whom I would not have had a chance to meet otherwise, were interesting and enlightening.

Samuel-Cahn: Was the census of industry a success?

Seiden: No. We did not summarize the results. At any rate, they would have become obsolete before we were ready to do it. But I had fun.

Samuel-Cahn: So you were out of work?

Seiden: No. The political situation became very tense. The problem of dividing Palestine into two states arose. I was transferred to the population section headed by Professor Roberto Bachi. We were asked to prepare the data for the Anglo-American Committee, which was supposed to advise the United Nations on how to divide the country.

Samuel-Cahn: What year was that?

Seiden: 1946. This assignment we did complete! We summarized the data, which we illustrated in a colorful map. We put blue dots for the Jewish population and red for the Arab. The colors were intermingled and illustrated the difficulties facing the Committee. The next project was given by the head of the English Statistics Department. He told Bachi to estimate the size of the population of Jerusalem for the year 2000.

Samuel-Cahn: Why would they be interested in the population of Jerusalem in the year 2000? That was some 53 years ahead, and with all the political uncertainty that already existed what did they expect?

Seiden: They ignored the political uncertainty. They were interested because there was no water in Jerusalem except for rainwater. There were some pipes from the Yarkon river, but in 1946 it was clear that this was not enough. So they had to build some new installations, and they wanted it to be sufficient for 50 years. Professor Bachi, although aware of the difficulties, felt that he should not refuse such a request. He asked me to be in charge of compiling the data. Even ignoring the prevailing political situation, the available sources were very meager. The information for the Arab population was based on the 1931 population census. As for the Jewish population, we included, in addition to the data about immigration, also data on the illegal immigration which were made available by the Jewish Agency Department of Statistics. I felt very confused by the methods we used to achieve our goal. For example, it was obvious that the data relating to age distribution, especially for the Arab population, were wrong. The estimates of the birth rate for the Arab population based on the 1931 census included women over 50 bearing children, and so on. So we used various smoothing methods.

Samuel-Cahn: Do you remember the estimate you came up with?

Seiden: No, because I left before this job was finished. I remember we came up with a number we did not like. So we changed the method and came up with another number. I just recently learned that all the files from the English Government Department of Statistics were transferred to the archives of the Israel Department of Statistics. It seems nobody was interested in looking at these data. Maybe I shall do so to satisfy my curiosity.

THE BERKELEY PERIOD

Samuel-Cahn: So when and why did you leave?

Seiden: I decided that I wanted to study statistics. I was happy in the Statistics Department. In fact, it was the first time I was happy at work. So there was no point studying mathematical logic. I realized that statistics was a new subject, and I wanted to study it. I took time off from my work to attend lectures in probability at the Hebrew University, which Professor Aryeh Dvoretzky was giving. I started reading R. A. Fisher. I wanted to understand the theory of statistics. But it didn't make sense to me. I was confused. So I spoke to Professor Fraenkel, with whom I was in touch all the time. He told me that there will always be enough mathematicians, but I might be the first Doctor of Statistics in the State of Israel. He was very friendly

with Professor Abraham Wald of Columbia University, so he offered to write him a letter, and he told me to go there to study. I was in touch with Tarski and knew he was in Berkeley. I wrote to him that I wanted to come to Berkeley to study statistics, not mathematical logic, and he answered that he had talked it over with Professor Neyman, who would be glad to admit me as a graduate student. I was very pleased to hear this, since I had been away from studies during 12 years. So I got a student visa to the United States and arrived at Berkeley for the spring semester of 1947. I didn't know how lucky I was because I could never have paid the tuition fee at Columbia University, whereas at Berkeley the tuition was very low.

Samuel-Cahn: How was your English at the time?

Seiden: Well, when I started working in the government Department of Statistics, I understood that the common language was English. I had never taken English, because the foreign language in school was German. So I went to the Berlitz School for Languages in Jerusalem in the evening and studied English. I could understand it, but I spoke English only in the office with the Arab colleagues and rarely with the head of the department. When I came to Berkeley I was lucky. There was an English exam for foreign students, and I am not sure that I would have passed it. But I came late, after the beginning of the semester, so they sent me to some English professor. She talked to me, and I understood what she said, and she said, "Oh, you will have no problem understanding the lectures," so she passed me. And I really didn't have any problem. After the first lecture of Professor Neyman, he asked me, "Did you understand anything, because of the English?", and I said "The English sounded very familiar to me." The Americans may have had difficulties with Neyman's English, but I didn't; his English was very pleasant to me! But I had difficulties with statistics. My idea was to come for one year. This meant I could not start from the beginner's courses, because where would I get after one year? So I registered for the course of Neyman, because he was the head of the department and he gave the graduate courses. Others in his course were Joe Hodges, Betty Scott, Evelyn Fix and some students working for a Master's degree. I didn't understand anything.

Samuel-Cahn: So what did you do?

Seiden: Well, I started working. I thought it was like when I moved from Wilno to Warsaw. The students of mathematical logic in Warsaw were ahead of me. But Tarski was a very good teacher. And nobody asked me whether I understood what he was saying. So I listened to his lectures, read the papers and tried to understand. There were no such obligations as midterms, homework or finals. What I understood was my business. So I registered for Neyman's course with this understanding that whatever I will get out of it is only my business. I didn't know the American system. After some weeks, Neyman went to Washington, and we had a "midterm." I didn't know what it meant. So I spoke to Neyman and told him, "You know I can't pass it." But he made me take it anyway. I figured there was the possibility that if I failed, since my visa depended upon my being a student, they would deport me and pay the expenses of sending me back to Palestine. But surely I didn't want this to happen. So I started studying hard and reading Neyman's papers. And other people such as Lehmann, Hodges and Neyman himself helped. When I asked Neyman questions, he never told me that the questions were foolish, but he explained things to me.

Samuel-Cahn: I take it you passed the exams.

Seiden: Yes. Neyman, gave take-home exams. And he passed me anyhow. That was the highest level course, with all graduate students and people who already had their Ph.D. I thought that I was going back after one more semester, but Neyman insisted that I should go for my Ph.D. The next semester, he made me take the first graduate course in statistics, which again he was giving. Then I was already ahead. I had no problems. I never told Neyman how I supported myself. I didn't ask for a fellowship, because why would he support a person of my age, who was coming from 3,000 miles away, without any knowledge, just to study for a year? So my plans were to support myself through housework, which I did. During the summer, I could get work picking fruit, so I did not plan to register for the summer session. But Neyman said that a famous visitor, Harald Cramér, was coming for the summer session to give a course in probability, and he wanted me to take it. And you know, with Neyman an order is an order, so what was I going to do? Then I saw a notice on the bulletin board stating that Professor George M. Kuznets, from the Agriculture Department, was looking for an assistant to do calculations on a hand calculator during the summer. I thought, "Maybe I can get this job since I know how to calculate from my work in Palestine. Then I can take Cramér's course." I knew Kuznets, because he attended the statistics seminars. I asked the secretary of the department to tell me the working conditions and asked whether I could be recommended for the job. She asked Neyman when he came back from lunch. He called me and said, "What do you mean? Why do you need to work for Kuznets? I thought that if the Government of Palestine sent you to study statistics they are paying your expenses. But if you want a job, I have such work." So as of July 1st, 1947, he gave me a research assistantship. The job was to work 20 hours a week, on an honor basis. I felt very rich. I am not short of money now, but there is no amount of money which would make me feel as rich as I did at that time.

Samuel-Cahn: What did your work consist of?

Seiden: My work was on a hand calculator. The first job was to do some calculations for a project of Betty Scott and Neyman, on some galaxies. I did not enjoy the first assignment, and in fact I was worried that as a result of it I might lose the job I so badly needed! Betty asked me to solve numerically some equation, and I was not getting the result she expected. This created a tension between us. She kept asking me to increase the accuracy of my calculations, and I kept obtaining the same result with greater accuracy. I felt that she did not trust my calculations, especially since she kept telling me that another student performed the same calculations and obtained different results. Finally, I found the mistake in the equation I was given, and when Neyman heard me shouting about it in the absence of Betty he took my calculations. The next day he told me not to continue working on this project. Later, I understood that Betty is a very kind and good person, and we became good friends. When she used to come to the computing room with some urgent calculations and found but me, she used to ask extremely politely if I would be willing to compute something. My reaction was, "I am not doing you a favor. This is my job." Then I did some calculations for Charles Stein. At the meeting where he reported his result, he thanked me for the calculations, and that was very pleasant. Then I did a job for Neyman and Jacob Yerushalmy of the health department. They had a model, and I had to take random samples to see how the model fits. I continued this until February 1948. In February, Neyman told me, "No more computing." He called up Herbert Solomon from the Navy Research Program and asked him whether he could give a research appointment to a foreigner. Solomon agreed, so Neyman told me, "Now you can do what you want to do." So I did not do any more computations until I got my degree.

Samuel-Cahn: When did you get your degree?

Seiden: September 1949.

Samuel-Cahn: Can you tell us about your research towards the degree?

Seiden: Soon after receiving the research assistantship, Neyman told me that I have to take my prelims in May, to get rid of the work not connected with my thesis. So I passed my prelims on May 3rd, the Constitution Day of Poland. (This was Neyman's idea!) The prelims were on the consistency of the continuum hypothesis. For that I didn't have to know much statistics. For the prelims one had to prepare a topic in mathematics with which one was not familiar and to give a talk in front of five professors, out of which at least two were real experts in the field. They used to interrupt the lecture with questions in order to find out to what extent the student delved into the subject. I didn't know the proof of Kurt Gödel, which is a masterpiece, but I was familiar with that area of research, so I got through that. After that I had to catch up with my courses for the close of the semester. Then Neyman told me to take the summer session and that after the summer, by October, I had to have a publishable result, because he supported me from the Navy project and now it was my turn to contribute to that. I tried to look for a topic for my thesis, going to various lectures, reading some papers. I was fascinated with the identifiability problems discussed by Tjalling Koopmans. I did not know exactly what I wanted to do, but I was determined that I had to find the topic myself. During the summer, Raj Chandra Bose was a visiting professor in Berkeley, and he gave two courses, which I took. One was in analysis of variance, the other in finite geometries and their applications. That fascinated me. He stated some open problems in this area which are very easily stated, but hard to solve.

Samuel-Cahn: If the problems are so easy to state, can you state some in a few sentences?

Seiden: For instance, one of them was to prove Euler's conjecture. The conjecture was that there do not exist two orthogonal Latin Squares of order $4t + 2$ for all t. This conjecture was already proved for $t = 1$. Many mathematicians believed Euler was right, so the next step was to prove the conjecture at least for $t = 2$, that is, for order ten. If I could construct two orthogonal Latin Squares of order ten, it would not disprove the general conjecture, but it would already be considered a big thing. Or to prove the conjecture, that would have been much more difficult. There were other problems. For example, there was the problem of determining the maximal number of points in a space of dimension greater than $t - 1$, no t of which lie on a $t - 2$ dimensional subspace. The simplest case was to find the maximal number of points, no 3 on one line, in dimensions higher than 2. Everything is so simple to describe. I was fascinated by the clarity of the formulation of the problems and the straightforward applications of the solutions, if obtained, to factorial designs and error correcting codes. I often felt confused listening to possible implications in other areas of the statistical theory.

Samuel-Cahn: But by then you already knew statistics.

Seiden: Surely. But the mathematical theory of experiments seemed to be applicable to very tangible and well-defined objects, which I accepted without any hesitation at that time. I was fascinated by the ideas. Then Neyman told me to ask Bose for a thesis topic. I was reluctant to do so, but I thought, "I have no choice, if I have to have results so soon." In my conversation with Bose I learned that my request was not simple. He was planning to return to India after the summer session and assume a Professorship at the University of North Carolina in the Fall of 1947. He had to prepare topics suitable for dissertations for

his future students there. However, he suggested a problem which he had stated in several universities during his visits preceding the summer session in Berkeley. The problem, in full generality, was to determine the maximum number of points in a finite projective space PG($r - 1$, s) (of r homogeneous coordinates each assuming s values) such that no t of the chosen points lie on a $t - 2$ dimensional space. He told me that in the simplest case, for $t = 3$, $r = 4$ he determined that this number is equal to $s^2 + 1$, when s is a power of an odd prime and between $s^2 + 1$ and $s^2 + s + 2$ when s is a power of 2. He suggested that I try first to determine this number for $s = 4$. He conjectured that the searched value for this case is somewhere within the lower and upper bound (17,22) without reaching any of them. The solution of the problem had an application to the theory of factorial designs and error correcting codes.

Samuel-Cahn: Did you decide to work on this problem?

Seiden: Yes. Neyman kept asking Bose to suggest a topic, and Bose used to answer, "I did, but I didn't encourage her to work on it since I did not see anybody wanting to work on it." My thought was that at least in the simplest case it should not be too difficult to determine the exact number. As soon as Bose left, I started working on the problem. At first I tried to verify the conjecture of Bose. When this failed, I noticed some perspectives which reminded me of Desargues' Theorem, and applying it led to the result that the lower bound is the exact value. I felt on top of the world and went to discuss the result with Professor Oscar Zariski from Harvard University, who was teaching during the summer session at Berkeley. He said I was right, but I was just lucky. So he advised me not to publish the result until I knew more about the subject, because otherwise others, who knew much more, would generalize it. He was a good friend of Neyman and told Neyman that in his view I should not yet publish. But Neyman insisted, so I wrote up the result. He sent it to some algebraist in the mathematics department, who returned it saying he was not in the area. Then he asked Professor Hans Levy in Berkeley to look at it. Hans Levy called him up and said, "This is wonderful, this is very exciting." I think he overestimated it because he did not work in the field himself. He told Neyman that I should not be given the usual assistantship. My salary increased considerably, and I felt comfortable indeed. I wrote my result up for publication with Professor Levy's help and submitted it to the *Proceedings of the American Mathematical Society*, where it was accepted. I wanted to continue working on this subject, but Neyman said, "No, this is not statistics; you will never get a degree in statistics this way." So I got some minor results in testing hypotheses. In fact, I would have continued being a

student; I was very happy this way, but Neyman said it was time to get out. He made me take the final exam by the summer of 1949, so I got my degree.

Samuel-Cahn: But weren't you anxious to change your status of being a student?

Seiden: Not at this stage. After being through with my course work and the prelims, I felt independent, doing every day what I was anxious to do, even if I had had no obligation whatsoever. I did face the problem of adjustment to the status of becoming a student when I arrived at Berkeley. There was the problem of getting integrated within a group of students much younger than me and of an entirely different background. My policy was not to ask any privileges and any consideration on account of my age. I was glad to see that I was well accepted. They treated me and behaved towards me as to one of their own, and I had many friends with whom I kept in touch even after leaving Berkeley.

STATISTICS AT OTHER INSTITUTIONS

Samuel-Cahn: Where did you look for a job?

Seiden: My idea was to stay one more year, to earn some money to buy some electrical appliances to take back to Palestine—which by then had become Israel. This was customary at that time. There was no real problem about staying for another year, because Neyman offered me a position of lecturer in Berkeley. There was a status for training, after obtaining a degree on a student visa, and Neyman thought it was legal to appoint me. Then Neyman wanted to extend my visa further, but the immigration office said this was illegal. So I had a choice of either applying for an immigration visa or going back to Israel. I didn't have any offer from Israel, nor did I have any contacts. I was quite sure that if I went back I would get an offer from the Israeli Central Bureau of Statistics, because Professor Bachi was now the head of the bureau, but I wasn't sure I wanted that. On the other hand, in the U.S. it wasn't difficult to get offers, because there weren't many statisticians. Betty Scott, who graduated at the same time I did, got an offer from Professor Zenon Szatrowski, Chairman of Statistics at the University of Buffalo. He had visited Berkeley during the summer of 1947 and knew I planned to go back to Israel. Since I knew that Betty Scott didn't plan to accept the offer, I applied for the job at Buffalo, and I got it. Neyman was in France at the time, and on his way back he stopped in Buffalo and set up very good conditions for me. My visa problems were finally settled just by my crossing on foot into Canada at the Niagara Falls! I was then issued an immigration visa on a meritorial status, at the intervention of Professor Neyman.

Samuel-Cahn: Was there a Statistics Department at Buffalo when you got there?

FIG. 8. *Meeting of American Mathematics Association in Buffalo, New York, 1950. Esther Seiden is second from left. Others are unknown.*

Seiden: Yes, there was a Statistics Department in the Business School.

Samuel-Cahn: How long did you stay in Buffalo?

Seiden: I stayed for two years. I never planned to retire in Buffalo. But the reason I left was that, because of the Korean War, the student population dropped, and, since Buffalo was a private university, there was a financial crisis. By December 1949, the university notified all faculty members up to the assistant professor level that their appointments would be terminated. This didn't affect me, since I was an assistant professor, but it clearly was disappointing. This reoccurred the next year, and I would have to take over courses of people laid off. So I decided to take a leave of absence for the Fall semester, and come back for the Spring semester. I had to decide what to do during that semester. Charles Stein was at the University of Chicago, so I decided to go there, just to be in a good atmosphere of mathematical statistics. During the Christmas vacation, I went to New York and visited the deputy chairman of statistics in the United Nations, Patrick Loftus, who was the chairman of the Government Department of Statistics in Palestine when I worked there. He was the person who encouraged me to go to study in the States, and he gave me a letter that, whenever I came back, there would be a suitable position for me. So when I visited him, he asked whether I would be interested in working in the United Nations, and I said, "No, not permanently, but I would for the summer only." So he gave me a position for the summer, and it paid more than what I earned for half a semester in Buffalo. Then I was offered a Research Associate appointment at the University of Chicago for the following year. I called the chairman at Buffalo to extend my leave of absence. The dean at Buffalo was very upset and disappointed, but I never went back to Buffalo.

Samuel-Cahn: So when did you move to Chicago?

Seiden: 1952. It was a very happy year in Chicago. Henry Daniels from England was there at the time, and I shared an office with him. Charles Stein, L. J. Savage, Bill Kruskal and K. A. Brownlee were there. The conditions were excellent. The teaching load of the regular lecturers was very low, and every day at 4 o'clock there was a coffee hour which was devoted to talking about problems in statistics. The interests of the participants were very diverse. Nevertheless, everyone could get the attention of others and talk about specific problems even if they were not of general interest.

Samuel-Cahn: What were the "hot" topics at the time? Can you remember?

Seiden: L. J. Savage talked about personal probability. It was always a pleasure listening to him and hearing the remarks of others. Charles Stein talked about problems of admissibility. He listened to remarks of other people and encouraged participation in finding solutions to his difficulties, in spite of being far ahead of most of the listeners. I was working, at that time, on a construction of an orthogonal array. When I thanked L. J. Savage or Charles Stein for their comments, they used to say, "We don't know how we helped you," but they did. Bill Kruskal talked about coordinate-free analysis of variance, and K. A. Brownlee about some applications. The other topics were simultaneous confidence intervals and applications of game theory to statistics.

Samuel-Cahn: Who was chairman at Chicago?

Seiden: Allen Wallis was chairman of the Committee of Statistics; there was no Department of Statistics at that time. His main interests were the application and dissemination of statistics. There was great admiration for him as an administrator. He encouraged participation in sharing the problems of the department from everyone, including visitors. Wallis obtained a Rockefeller Foundation Grant for researchers who were in fields other than statistics or mathematics. We all read the files of applicants and discussed them at the meeting. Among this group, I remember two prominent candidates. One was Dick Gundy, who had a Ph.D. degree in psychology from the University of Indiana and is now a professor at Rutgers University. The other was Pinhas Naor, who had a Ph.D. degree in metallurgy from the University of Birmingham in England and who was later a professor of Operations Research at the Technion, Haifa, Israel.

My problem was what to do next? I could not rely on Neyman, because he was mad at me for having left

Buffalo. He kept saying that because of me Buffalo would not have a department of statistics.

Samuel-Cahn: Couldn't you stay at Chicago?

Seiden: I didn't think I could stay in Chicago. But when Charles Stein resigned, Allen Wallis told me that I could stay another year, this time as an Assistant Professor. Wallis was mostly interested in people with an interest in applications, and he kept hinting that I was not an applied statistician.

Samuel-Cahn: Was that correct?

Seiden: Yes, to some extent. Anyway, he was nice to me. He told me that for the next year I would be teaching a course in multivariate analysis! I was worried about teaching this course, but had no choice, since generally the conditions were exceptionally good. So I approached Ingram Olkin, who sent me notes of P. L. Hsu from North Carolina. I taught the course, using the notes, and it wasn't easy. In my class were Morrie DeGroot, who went to Carnegie Mellon University, and Roy Radner, who became a professor at Berkeley and is now at Bell Laboratories. Somehow, I managed. Again my problem was what to do next. Then I heard that David Blackwell was going to Berkeley on a visiting appointment. At that time, Blackwell was at Howard University in Washington D.C. I called Blackwell, telling him that I would like to come to Howard. My idea was that I would stay at Howard when Blackwell came back, as he used to do during the past 14 years. Then I would have the advantage of being in a department with Blackwell. Also, the experience of teaching in a black university was fascinating.

Samuel-Cahn: Was Howard an all black university?

Seiden: There were very few white students. It was founded with the idea of being an integrated university. But white students didn't register, except to special programs, such as the medical or law school, and also the ROTC (Reserve Officers Training Corps) program. There were very few white professors.

Samuel-Cahn: How long did you stay at Howard University?

Seiden: One year. In December, just a few months after my arrival, I was offered an extension of my appointment. I had some reservations regarding the scientific atmosphere and felt uncomfortable at being considered different, even though everyone, faculty and students, were very friendly. I heard rumors that Blackwell was being offered a permanent position at Berkeley and that he would not return to Howard. Nevertheless, I accepted the offer, wanting to learn and understand a community I had not met before. In March, I was told by the chairman of the department that since Blackwell was returning next year to Howard there would be no money to pay my salary and the offer had to be withdrawn. In the meantime, I received a research grant from the Numerical Analysis Institute

at the University of California at Los Angeles, for the summer, and I was looking forward to this.

Samuel-Cahn: On what did you plan to work?

Seiden: I had some idea to try to construct at least two orthogonal Latin squares of order ten. I told Tommy Tompkins, who was, I think, the head of the institute at that time, about it, and he encouraged me to try out my appproach. Later, in a meeting which took place in New York, "On the Present State of Two Orthogonal Latin Squares of Order Ten," he reported on my approach.

Samuel-Cahn: Did you have any success during that summer?

Seiden: No, but the struggle with the problem was exciting, and life was not dull. Another group of mathematicians, much more advanced than me, worked at the same time using another approach to solve the same problem. We communicated with each other, and they encouraged me to continue working.

Samuel-Cahn: Did you try to get another position in Washington, D.C.?

Seiden: Yes. Shortly after I came to Howard, I received a call from The American University asking me to teach a course based on the book of David Blackwell and M. A. Girshick (*Theory of Games and Statistical Decisions*, Wiley, 1954), which had just come out. Blackwell was giving this course before leaving Washington. I was scared to assume such a responsibility, but I accepted the offer. I was asked to teach the course during the spring semester of 1955. I started studying the book and solving the problems. The game-theoretical approach to statistics was very appealing to me. Before the start of the semester, I received a call from The American University that fewer than ten students had registered for the course. (It seems that students had heard that Blackwell would not be teaching the course.) I would be paid per student and not the usual amount. In such a case, I had the option to back out. Since I was scared to teach the course, I told the chairman that my decision was to use this option. However, I yielded to the request of the chairman to meet the students for the first lesson. The chairman came to meet me and told me that he would pay me the full amount anyhow.

Samuel-Cahn: How many students were there?

Seiden: By then there were about 10. Mostly, they were mathematicians working in various institutions in Washington who wanted to learn something about game theory and statistical decision theory. In the course, there was one young student, Dorian Feldman, who was so much better than the rest. I wondered why such a young talented person was taking courses in an evening school. He told me that he was working in a Navy proving ground office near Washington, earning money, which would enable him to be admitted into a good graduate school the following year. In the mean-

time, taking graduate courses in statistics and mathematics would enhance his chances to reach that goal. I recommended him to Neyman, and he was in fact admitted to Berkeley. I was glad to hear that my judgment was correct. His thesis, obtained under Blackwell's supervision, was a hit. He contributed to the solution of the "Two Armed Bandit" problem. Blackwell was surprised listening to his result and told him that more advanced statisticians had tried, unsuccessfully, to make progress towards the solution of this problem.

Samuel-Cahn: Wasn't American University considered a good school?

Seiden: The day school was not considered a good school. In the evening school, there were good people giving courses, such as Eugene Lukacs, Blackwell and others, who, for some reason, were not connected with a university and wanted to keep in touch with teaching. So the graduate courses were on a high level. But it was not considered a good university for a proper graduate student.

Samuel-Cahn: What research did you yourself do at the time?

Seiden: I was working on determining the maximum number of constraints of an orthogonal array and related problems which had applications to the theory of fractional factorial designs. I also continued to try to find a way to construct at least two orthogonal Latin Squares of order ten. This led to the invitation for the summer of 1955 at the Numerical Analysis Institute at U.C., Los Angeles.

Samuel-Cahn: How did you end up at Northwestern University?

Seiden: I got a call from Northwestern University that Meyer Dwass was going on leave of absence to Stanford and would I replace him? I was glad to accept, because it was very close to Chicago, and it was a very good department.

Samuel-Cahn: Who was on the faculty at Northwestern?

Seiden: There was R. P. Boas, who was the chairman, a known Bourbaki member, Jean Dieudonné, Alex Rosenberg, Daniel Zelinsky and other good mathematicians.

Samuel-Cahn: Did you teach mathematics or statistics?

Seiden: I gave a probability course based on Feller. And I taught courses in calculus and in differential equations, and I enjoyed it. Sidney Port, now a professor at U.C., Los Angeles, was then a graduate student at Northwestern. He took a reading course with me based on Blackwell and Girshick's book.

Samuel-Cahn: How long did you stay at Northwestern?

Seiden: Five years. Meyer Dwass came back the next year, but Boas told me that I could stay anyhow, because each year someone else was going on leave of absence or got some research grant. After two years I got a call from Michigan State University offering me an appointment for three years. I went to Boas and told him. It was Friday afternoon. He said, "What, wait a minute!" He went to the Dean, and by Monday gave me a signed appointment for three years at Northwestern! I stayed there, but during the fourth year was at the Indian Statistical Institute.

Samuel-Cahn: How did you end up going to India?

Seiden: To solve the geometrical problems I was working on, I would have to know high-speed computing. So I started to get interested in computing.

Samuel-Cahn: Weren't high-speed computers just coming out at that time?

Seiden: Yes. IBM invited 22 people from various universities, because they wanted university people to get interested in high-speed computers. I was one of the 22, and I went to New York. My assignment was either I attend a course and learn programming (which was in the machine language, at that time) or I write a program which runs, thereby proving that I had learned programming. So I wrote a program for constructing orthogonal Latin Squares of order ten, using some geometrical conditions. After completing my program, I thought that I would like to write another one aimed at a bona fide statistical program. I talked the matter over with Herbert Robbins, who was then at Columbia University. He was working on a statistical problem for the IMS meeting in Atlantic City and wanted some numerical support for his result. I did the computations on the computer, and he included them in his lecture. People knew that I was interested in computing and in the design of experiments. C. R. Rao and P. C. Mahalanobis knew about it; also in the United Nations, Loftus, the chairman from my statistics job in Jerusalem, knew about my interests, and I got an appointment to the International Statistical Educational Center (ISEC) at the Indian Statistical Institute.

Samuel-Cahn: Were you there a whole year?

Seiden: Yes. The ISEC sponsored teaching statistics, economics and some other applied subjects in several locations. One of them was the Indian Statistical Institute. The students were from underdeveloped countries from the surrounding area. There was clearly no difficulty in appointing faculty belonging to the Indian Statistical Institute for this purpose. But the teaching faculty that year was almost all foreigners. The head was a member of the UN Statistical Office, Dr. Dirksen, a Dutch statistician.

Samuel-Cahn: Was the whole group in Calcutta at the same time?

Seiden: Yes.

FIG. 9. *Esther Seiden lecturing at the Indian Statistical Institute in 1958. Note hand calculators at every desk.*

Samuel-Cahn: How many were you?

Seiden: About four to five—teaching various courses in statistics and economics.

Samuel-Cahn: Tell us about your experience.

Seiden: The conditions were very good. I stayed in the foreign students' dormitory for women. The students were two to three in one room, but I had my own. I tried to work on the problem of designs. So when I came I told them I wanted to use the high-speed computers. They had a small English "Hollerit" computer and a "Ural," which they had gotten as a donation from Russia. Eight Russian engineers were mounting it. It was a slightly modernized version of the IBM 360. In addition to the exaggerated number of engineers engaged in such a job, there was also a person who was explaining to the Indian engineers how to take care of the computer for when they would be in charge of it. It seems that he was not.an engineer and didn't know sufficiently the technical language. As a result of this, the Indian engineers were lost. The situation was remedied when an Indian engineer who had spent some time in Poland took over his job. I felt that the Indian engineers could have mounted the computer themselves. What they needed was some indoctrina-

tion in their attitude towards a computer. When the computer was given over to them and the Russians went to downtown Calcutta to celebrate, the Indian engineers went to have their afternoon tea hour and left the computer working unattended. This shocked the Russians. I learned the language of the Ural and wrote a program for it.

Samuel-Cahn: Did you manage to solve any problem by computer?

Seiden: No. I was trying to construct lines of a PG (2,10) finite projective plane with eleven points on a line, under the assumption that there exists an oval of twelve points.

Samuel-Cahn: What is an oval?

Seiden: An oval is a set of no three collinear points. The assumption of the existence of an oval gave twenty-one lines of the plane for free. I tried to construct additional lines with the help of the computer, under some additional assumptions. Otherwise, the choice for additional lines was too big. The existence of such a plane is equivalent to the existence of nine mutually orthogonal Latin Squares of order ten. I hoped that this way, even if the construction failed because such a plane does not exist, I might be lucky

to find some orthogonal squares. I believe that I found two orthogonal squares this way but could not extend the construction any further. This was frustrating, but at that time I enjoyed other aspects of life. The experience of spending the year in India was exciting. The atmosphere in the institute was very enlightening. There was a group of brilliant young graduate students engaged in serious research, mostly in probability and a few in statistics. Their accommodations were very modest, but the research conditions were excellent. They had free access to a very good library. Mahalanobis used to invite brilliant scholars from outside, such as A. N. Kolmogorov, Norbert Wiener, Neyman and others. There was also a very interesting permanent resident, J. B. S. Haldane. I enjoyed the conversations with the students and Haldane during the tea hours even though the conversations were neither on probability nor on statistics. The students I still remember were Varadhan, Varadarajan and Sethuraman. Raj Bahadur was also at that time at the institute. In fact, I. M. Chakravarti was working in design of experiments, but I had no contact with him.

MICHIGAN STATE UNIVERSITY AND MORE VISITS

Seiden: I came back just for one year to Northwestern University, and Olkin came to a meeting in Chicago and told me, "You can now get another offer, on a permanent basis, in Michigan State University, and it is time that you move to a department of statistics." I agreed with him. I accepted the offer from Michigan State, with the understanding that I would be engaged partly in consulting, and I knew something about computing, so my first appointment was as an Associate Professor, but with part-time consulting duties.

Samuel-Cahn: Who was at Michigan State at the time?

Seiden: Olkin had just left. Leo Katz was the chairman. And then there were Kenneth J. Arnold, Martin Fox, Jim Hannan, Jim Stapleton, Herman Rubin and Gopinath Kallianpur. It was a big department.

Samuel-Cahn: What year was that?

Seiden: 1960. It was the first time I felt that I was a bona fide faculty member of a Department of Statistics. We had very good relations with the Department of Mathematics. We had a program for graduate students working for the M.Sc. and Ph.D. degrees in statistics. We also gave service courses for other departments. One of our big customers was the Business School. In the early sixties, we were asked to teach a game theory oriented course applied to business decisions. I was one of the teachers of this course. I got interested in the subject, and, together with Dorian Feldman, who arrived at MSU a year later, we wrote notes for such a course. We planned to expand the notes and write a textbook on the subject. A few

FIG. 10. *Esther Seiden at an April 1973 meeting in Fort Collins, Colorado, with Jack Kiefer and unknown person.*

years later, the interest of the business school in this approach dissipated, and we gave up the idea of writing the book. I taught service courses for the agriculture department, home economics department and others. For the statistics students, I taught courses on linear models and regression theory, and occasionally a special course on the mathematical theory of design of experiments.

Samuel-Cahn: Did you have any Ph.D. students?

Seiden: Yes. I enjoyed working with Ph.D. students very much. First of all, I enjoyed having, within the department, somebody interested in discussing problems of my main interest and working together to solve them. Nobody among the faculty had any interest in this area of research. Until then, I could talk on the subject of my research only with statisticians I used to meet in various meetings. One of them was Jack Kiefer. He suggested and encouraged me to do extensive work on determining the maximum number of constraints of a class of orthogonal arrays, which I did with Rita Zemach, one of our Ph.D students. I made closer contact with Kiefer during the summer of 1969 and thereafter. I received an invitation from Walter Federer to visit the Biometrics Unit at Cornell during the summer of 1969. I welcomed this invitation, hoping that this would bring me closer to applications of the theory of design of experiments. I cannot say that I achieved this goal, but this was one of my happiest summers. Walter Federer was an exceptionally generous and broad-minded project leader. I was not sure what he expected from me in return. He did not put forward any demands. I was given a big office in Warren Hall, the location of the Biometrics unit. I invited S. A. Hedayat, who was just getting the Ph.D. degree, to share the office with me. We started joint work

on a method he called sum composition of orthogonal Latin squares and on F-squares and orthogonal F-squares.

Samuel-Cahn: What is sum composition, and what are F-squares?

Seiden: A method of sum composition of orthogonal Latin squares consists of combining two Latin squares of certain related orders to obtain Latin squares of order equal to the sum of the components. One special case of our result was obtaining in a very simple way two orthogonal Latin squares of order ten by combining Latin squares of order seven and three. F-squares are a generalization of Latin squares by which each element appears the same number of times in each row and in each column, not necessarily once only. Such squares have an application to factorial experiments and can be used even when orthogonal Latin squares do not exist, for example, of order six. The summer work was a success and very enjoyable. In addition, I gained a close friendship with Federer and Kiefer, and visited Cornell many times thereafter. In one of my later visits to Cornell, I was present at the discussion between Federer and Kiefer in which Kiefer pointed out the necessity to develop a method of construction of generalized Youden designs (GYD) which satisfy some optimality criteria, first pointed out by A. Wald and extended by Kiefer. Two of my students, Felipe Ruiz and Ching-Yung Wu, worked on this topic and obtained nice results. I enjoyed greatly working with them. Ruiz also made a contribution to the method of sum compositions. With Wu, I worked on extending the method of sum composition to construct three orthogonal Latin squares. We realized that, except in obvious cases which have to be eliminated, this should be possible, provided that a certain theorem in group theory holds which looked very plausible and could be verified in some examples. However, we could not prove the required theorem. I approached several mathematicians working in group theory asking for help but did not get it. Finally, while attending an international meeting of mathematicians in Amsterdam, I got J. H. van Lint interested in the problem. Several months later, I received a reprint of a paper by five mathematicians in which they proved a generalization of the theorem we needed. Another student of mine, J. Rafter, worked on a generalization of orthogonal arrays called "partially balanced arrays," which were first introduced by I. M. Chakravarti. J. N. Srivastava and D. N. Chopra called them "just balanced arrays" and made major contributions to this subject. Rafter obtained nice results in this area of research, which have important applications to the theory of fractional factorial designs.

Samuel-Cahn: How did your students do after leaving MSU?

Seiden: None of them made further contributions to the mathematical theory of design of experiments, but they did well otherwise. Rita Zemach worked in the Government Office of Statistics of the State of Michigan and became the head of one section there. She was also active in advancing the position of women in statistics. Felipe Ruiz received an invitation from Washington to become a consultant statistician for the government of Brazil. He had no language problem, since he grew up in a part of Spain where the local pronunciation was close to Portuguese. I heard that he later returned to Washington. Rafter became a consultant statistician of the pharmaceutical company Johnson and Johnson, and soon advanced to head of the statistics section there. I used to get letters from some corporations expressing interest in appointing him, but he was not interested in moving and is still there. My hope was that Wu would continue working in the theory of design of experiments. After graduating, he was a research associate for one year, at Colorado State University, and I have lost contact with him.

Samuel-Cahn: How did you get to go to the University of Istanbul in Turkey, as a Fulbright Lecturer?

Seiden: That was in 1964. Louis Guttman, whom I knew, visited Michigan State, where he gave a series of lectures. He asked me whether I would be interested in visiting Israel, and I said, "Gladly." So he said he didn't know what appointment he could get me, but I told him he shouldn't worry about an appointment. "Since I am an American citizen, I can apply to the Fulbright Commission for sending me somewhere, and I will state that I know Hebrew and that my specialty is design of experiments. If you apply for a statistician, a specialist in design of experiment, then they will surely match us." So we agreed on that, and I applied. But when the booklet from the Fulbright Commission came out, there was no request for a statistician from Israel. So I thought, O.K., then I don't go! But then I got a call from Washington: would I go to Istanbul? I said, "I don't know Turkish," but they said I could lecture in English and would have a translator. So after a week of debating I accepted.

Samuel-Cahn: Can you tell us about that experience?

Seiden: I was assigned to the Forestry School in Istanbul. The lectures were translated, and the students were not very interested. It was not a compulsory course. But the experience was interesting.

Samuel-Cahn: How long did you stay?

Seiden: For a full year. And in December, I got an invitation to go to Cyprus, and again they thought I was an expert in forestry, and they brought a group of forty forestry students. I didn't know what to do, so I told them about inductive behaviour, the ideas of statistics, etc., and they enjoyed it very much. They decided that instead of sending students to study statistics in the States, they would invite visitors!

Samuel-Cahn: Did you acquire any contacts with Turkish statisticians during the year?

Seiden: No. I went to the forestry department. There were people in agriculture and economics. There was also a very good School of Technology. I went to the mathematics department there to get contacts. But it wasn't easy, especially since I didn't know the language. All professors in Turkey know two foreign languages, one of them to that extent that they can lecture in it. This is a condition for obtaining a Ph.D. Many knew German, English or French. So I made friends there, and I learned things about a people I wouldn't have met otherwise. My assistant who translated the lectures was working towards a Ph.D. degree. He got interested in statistics and wanted to study at MSU. I tried to get a fellowship for him through the American Aid Program, but the regulations of the graduate studies in Turkey were very stiff, and the matter could not be worked out. Another student whom I met in Ankara came to MSU with the intention of getting a Ph.D. degree in Statistics, but he could not adjust to the American system and returned to Turkey.

Samuel-Cahn: Did you go back to Michigan State after the year?

Seiden: There was the International Congress of Mathematics in Moscow. So, after I left Turkey, I went to that Congress, on my way back. There I wanted to meet mathematicians whose papers in graph theory I had been reviewing for the *Mathematical Reviews*. One of them was A. A. Zykov. I told Zykov that I had a sabbatical coming up and that I would like to spend it in Russia, on an exchange basis. He said he would like me to come on an exchange basis such that he would also be able to come to America, but that this was completely unrealistic. But he told me that, upon my return to the States, I should apply to the U.S. National Academy of Sciences for an exchange fellowship. Somebody in Russia would have to accept me, and he would gladly be the one. So I came back to the States and applied for an exchange fellowship for three months. I later regretted that I didn't apply for longer, but I thought it would be enough. I though a longer period would be a waste of time as far as my scientific work was concerned. But this period would enable me to get used to spoken Russian, and it would be an interesting experience. My plan was to spend the rest of the sabbatical at the University of Illinois, with E. T. Parker, one of the people who disproved Euler's conjecture. The stay in Illinois was interesting; J. L. Doob, Don Burkholder, Bob Wijsman and Dick Gundy were there. But as far as my own interest, there wasn't much, because Parker was sick and was not well enough to discuss mathematics.

Samuel-Cahn: Is there anything more you want to tell about your stay in Russia?

Seiden: When I came there they accepted me, but I was disappointed about their attitude towards me. I don't think it was a general attitude. But I went to Novosibirsk, which was known not to be for visitors. I was told, before I went there, that I would be the first visitor accepted for an extended stay. Zykov was there, but he didn't have enough experience with visitors. So he gave me a very detailed schedule, what I had to do every hour of the day.

Samuel-Cahn: Maybe he was told he had to?

Seiden: No, it seemed he was afraid and didn't know how to act. And he saw I wasn't comfortable with it. In some ways, I felt like I was in a prison, and he noticed this. He apologized and said it had to be this way. I don't think he was right. I still have saved the schedules which he gave me! Nevertheless, I enjoyed the three months of my visit in Russia very much. My type of visa was from three months up to a year. For the first three weeks, I was sent to Leningrad (now Saint Petersburg or Petrograd) because Zykov was temporarily absent from Novosibirsk. My host there was Yu V. Linnik. I enjoyed the city and the atmosphere in the Steklov Institute very much. There were several young talented mathematicians, interested in statistics and number theory, in the department. I attended a seminar led by Linnik in which the students discussed the book of E. B. Dynkin which had just appeared. There was no doubt that most of the students prepared for their lectures very well. I wondered why Linnik used to interrupt their talks so often by questioning them. One of the faculty told me that this was the way Linnik saved time. Instead of reading the book, he asked his questions in a very polite matter, and the students did their best answering them. On Linnik's request, I gave my first lecture in Russian at the University of Leningrad after I got somewhat used to the conversational Russian language. Linnik himself was not present at the lecture because he just returned from his visit to Moscow, where he fell sick. I have not seen him since then. From Leningrad, I was sent to Academgorodok, a science city constructed during the Second World War, a suburb of Novosibirsk. I was again impressed by the scientific atmosphere and the facilities given to the students and faculty to develop their potential talents. There were several leading mathematicians there such as Wassily Leontiev, L. V. Kantorovich and others. In the graph theory group, there were young very talented mathematicians such as Vizing and others. I got acquainted with a young man, J. S. O. Aliev, a student of Malcev (who died shortly before my arrival), and we wrote a joint paper on strongly regular graphs, which had application in the theory of partially balanced designs. I gave several lectures in the seminar of Zykov and on his suggestion also addressed the Siberian Branch of the Mathematical Society. I attended the seminar in probability which was led by two known probabilists, Borovkov and

Nagayev. The seminar was devoted mostly to presenting new results obtained by students and faculty. Before leaving Novosibirsk, I accepted the offer of Zykov to visit Central Asia. I enjoyed visiting Tashkent, Bukhara and Samarkand. I was especially impressed by the statistics group in Tashkent led by a younger brother of Nagayev in Novosibirsk.

Samuel-Cahn: Then did you go back to Michigan State?

Seiden: Yes.

Samuel-Cahn: How long were you on the faculty at Michigan State University?

Seiden: From September 1960 until I retired in December 1978.

Samuel-Cahn: I assume that you liked it there.

Seiden: Michigan State University was the first place of employment in which I had the feeling of belonging, not of being an outsider. It was the first place I felt concerned and involved in any problem the department was facing. The fact that I was the only member of the department interested in the theory of design of experiments did not bother me at all. There was no difficulty in getting professional contacts with colleagues in other universities. I also had close personal friends in the department. Shortly after arriving at the university, I became integrated into the family of Ken Arnold, who was then the acting chairman, and I still feel a member of his family now too. I had close friends in other departments. The cultural environment was also quite satisfactory; the university has a good lecture / concert series. My contribution to the activities of the department, aside from teaching, was to be in charge of the statistical seminar. I did this for fifteen out of the eighteen years I stayed at the university. Departing was not easy, but I knew that it couldn't be helped.

BACK TO ISRAEL AND FUTURE PLANS

Seiden: In 1978, I made an agreement with Israel — in fact, with you. You may not remember, but you were the chairman of the Department of Statistics at the Hebrew University at the time.

Samuel-Cahn: What was the agreement?

Seiden: I wanted to go to Israel, but I didn't want to come as a private citizen. So I wanted an official status at a university. After a few months, I got an official letter from the Hebrew University, appointing me as a Visiting Professor. First I got an agreement for two years, or more. Then there was a rector who refused to give a long-term agreement. So now I get a new appointment every year.

Samuel-Cahn: Actually, you have a better arrangement than our local emeritus professors. I don't think they are allowed to teach for that many years after retirement. So you have a special status here.

FIG. 11. *Esther Seiden, 1985.*

Seiden: That is nice, because this way I am in touch with students and the world. I also get letters here.

Samuel-Cahn: I understand you are also in charge of the Departmental Seminars at the Hebrew University, and you have been in charge of these for many years.

Seiden: Yes, and that I enjoy very much, because it also gives me a chance of getting in touch with other people. I have no difficulty in getting speakers.

Samuel-Cahn: And are you still doing research?

Seiden: I didn't give it up, you see! Until I retired, most of my research was not motivated by the prospect of usefulness of the results I wished to obtain. My philosophy was that for practical applications only small-size designs were needed, and those were obtainable by trial and error; often applied researchers were very successful in constructing them and did not bother to generalize them. However, I was clearly glad whenever some of the general results obtained by researchers interested in the theory of construction proved useful for applications. Orthogonal arrays which were introduced to solve problems in theory of fractional factorial designs were soon found applicable to the theory of error correcting codes. Recently, the interest in orthogonal arrays was greatly revived due to the work of Taguchi, a Japanese engineer, who pointed out their usefulness in industry. Reading and refereeing some recent papers in this area renewed my interest in the subject. However, I would be very happy if I could make some contribution to the theory of analysis of widely used designs. When I was a student, more than forty years ago, Neyman pointed out to me the deficiencies in the analysis of commonly used designs. He urged me to work on correcting them. At that time, I felt totally unfamiliar with the subject and did not dare to start working on it. Up to now, very little has been done in this direction. Now I feel that even the balanced incomplete block designs which are "universally optimal" by some criteria are not quite

adequately analyzed. Two such designs with the same values of parameters are indistinguishable even if they differ considerably in their block structure. This information is completely lost in the analysis. I would like to make a contribution in this direction. But I am not trying to construct new designs anymore.
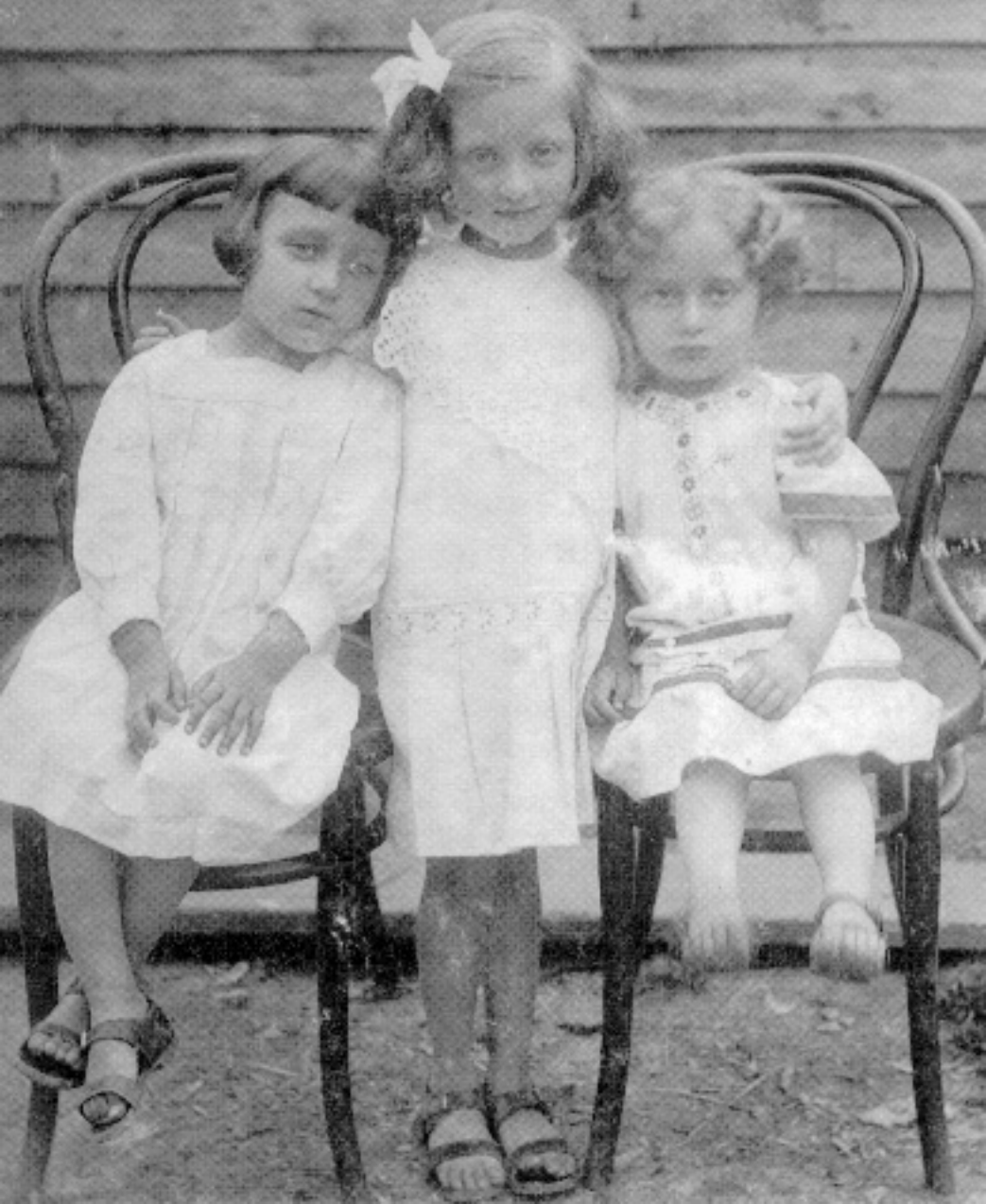
Samuel-Cahn: Is that your plan for the future? To write a paper about the statistical analysis of designs?

Seiden: I would like to contribute something beyond the construction. Given the design, how can one extract all the information that this design provides? That has not been done.

Samuel-Cahn: That's a very nice project, Esther. We look forward to a paper of yours explaining how to extract all the information available in the design. We all wish you many continuing fruitful years, and thank you so much for this interview.
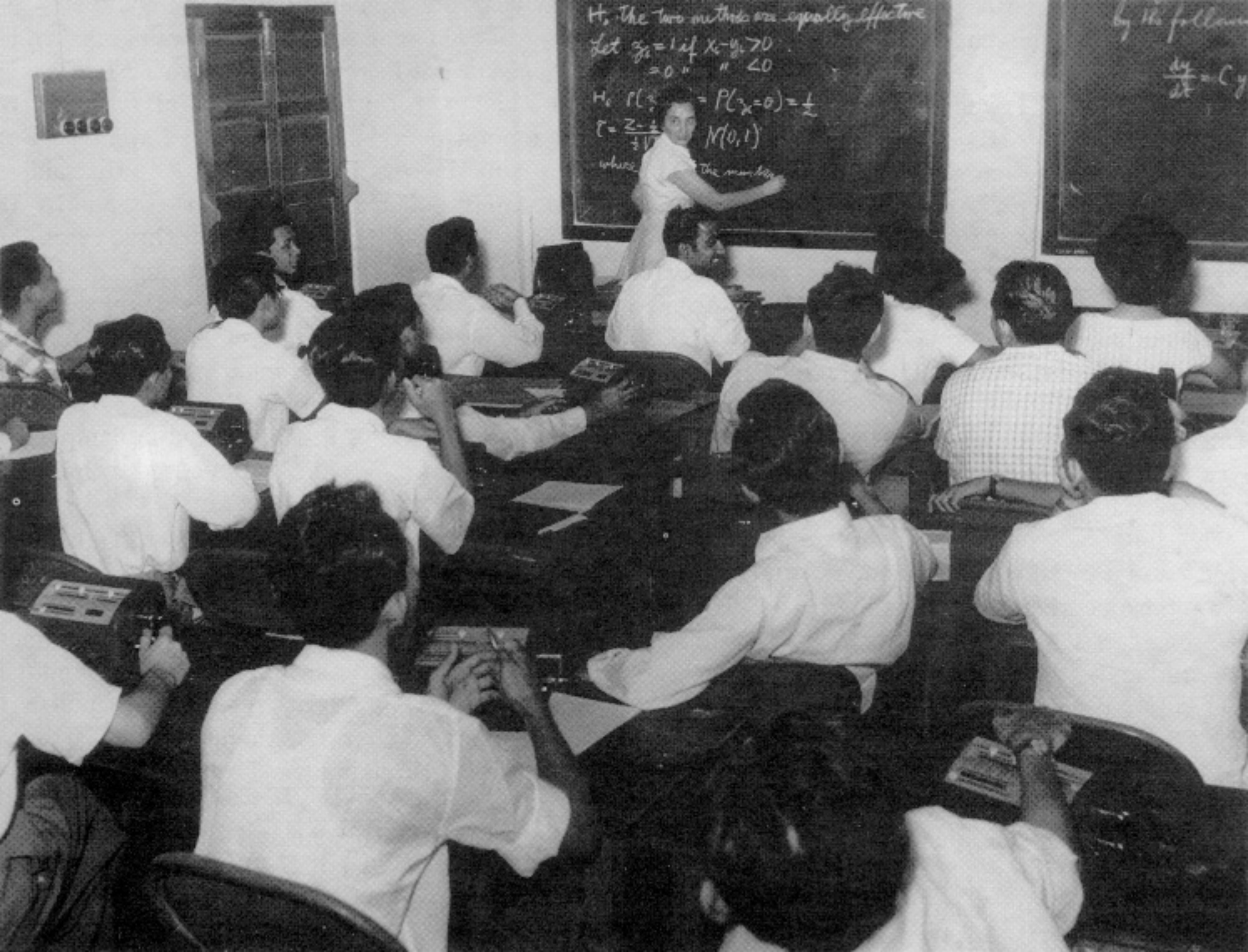
Seiden: Thank you!