continued from page 15

the fundamentals of different subjects. A survey of instructors who teach first-year university courses, asking what skills and knowledge they expect of entering students, would provide a solid basis for such programs. Equipped with programs of this sort, teachers could concentrate on *how* to teach instead of *what* to teach.

Changes also must be made at the university level, where teachers themselves are trained. An option should be added to the standard four-year bachelor's degree in education, in which students would receive a professional degree for doing an additional year of student teaching. The extra student teaching would both provide a pool of qualified aides in the classroom and give new teachers more experience.

As President George Bush recently recognized, the goals of the educational system in the United States must be critically reexamined, and the results of such thinking must be debated, explored and acted upon. The above suggestions would serve as a starting point for such reform.

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8/91

The German Minds Behind Russia's Bomb

I would like to augment the letter from Abraham Pais (August 1990, page 13) about the history of the Soviet atomic bomb.

First, although Peter Kapitsa may have taken part in consulting with Stalin in November 1942 and led a series of lectures on general topics of nuclear physics in summer 1944, he was the only top-class physicist who refused to work on the bomb project for Stalin. Kapitsa was punished by being exiled from Moscow to his country house. That might explain why he apparently hadn't heard of Klaus Fuchs, who spied for the Soviets, when he entertained a group of US scientists (including Pais) in 1956.

Second, Pais made no mention of the role of the German scientists who were brought into the USSR at the beginning of June 1945. Ulrich Albrecht, professor of peace and conflict research at the Free University of Berlin, writes the following in the April 1989 issue of the German magazine *Bild der Wissenschaft*:

"Three groups of mostly forcibly relocated German scientists and engineers participated in the building of the Soviet atomic bomb:

▷ the group around Nikolaus Riehl—entrusted with the production of pure uranium
▷ the group around Gustav Hertz
▷ the group around Manfred von Ardenne.

"There also were single scientists like the physical chemist Max Volmer, the physicist R. Döpel and the physical chemist Peter A. Thiessen."

Albrecht's article makes a number of references that imply that the relocation of the German scientists was forcible, although it gives no direct evidence:

"Besides the Soviet descriptions of the development of the atomic bomb, there are . . . reports from those German scientists and engineers who participated, more or less involuntarily, in at least 12 groups working on the Soviet postwar armament—some of them in prominent positions.

"At the beginning of June 1945, before the first American nuclear explosion (on 16 July 1945), the most important German scientists were flown into the Soviet Union. In one systematic operation the NKVD [the Soviet secret police] fetched those German physicists who were to participate in the bomb project. . . . [NKVD head Lavrenty] Beria's deputy and the operational director of the Soviet bomb project, NKVD General-Lieutenant Abram P. Saveniagin, came to Berlin-Friedrichshagen expressly to get the researchers who had participated in the German uranium project."

As to the details of the work, Albrecht writes:

"The German group of experts began in summer 1945 to melt and cast the uranium metal that they had brought with them in powder form in dismantled ovens from Germany. . . .

"The Nobel Prize winner Gustav Hertz (a nephew of Heinrich Hertz of electromagnetic wave fame) and his working party made progress in the diffusion cascade for the large-scale production of U-235 for the Soviet Union after 1945. . . .

"The German expert Dr. Schütze developed a mass spectrometer for heavy atoms, with which one could precisely measure the isotope ratio in the enriched uranium. . . .

"In the beginning the uranium production did not go well, but at the start of 1946 the Riehl group produced within a few days several tonnes of reactor-grade uranium oxide. . . .

". . . Physicist Heinz Barwich demonstrated a method for building gas-stream cascades for uranium separation without rectifiers. . . .

"The Germans were always deployed when there was no progress on the Soviet side. . . .

"The Russians had considerable problems with corrosion of the separation plants caused by uranium hexafluoride. Thiessen and Barwich participated in the troubleshooting. . . . The year 1946 brought the decisive technological breakthrough for the uranium project: a process, developed by the Germans, for converting raw uranium oxide to another fluoride compound, uranium tetrafluoride, as the basis for uranium extraction. . . .

About the role of espionage Albrecht writes: "According to the reports of the German scientists, the espionage results were brought repeatedly into their work. . . . Further there are peculiar changes in the direction of the Soviet project that suggest espionage." What's more, "one day the workers on the nuclear project got a memorandum that 'their' uranium was purer than the American weapons-grade material."

Finally, in an article about von Ardenne in the August 1990 issue of the German popular science magazine *Hobby*, entitled "He Served Hitler, Stalin and Honecker," Volker Petzold writes: "During the Hitler era the multi-genius von Ardenne already was working in an underground laboratory in Berlin-Lichterfelde on the development of an isotope separation plant. After the capture of Berlin the Russians shipped him, his coworkers and all the research installations of the 'Reichs-Laboratorium,' which he directed, to the East. In one strictly restricted research complex near the Black Sea town of Sukhumi, von Ardenne's team developed for the Soviets a plant for the production of nuclear fuel. . . . Stalin paid him a princely sum for it."

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Speakers: Learn to Project (Slides, That Is)

In his article "Advice to Beginning Physics Speakers" (July 1991, page 42), James Garland fails to mention a most important aspect of showing transparencies and slides: They should be easy to read at the back of the room. It never ceases to amaze me how many senior lecturers present viewgraph after viewgraph of material that is effectively invisible to anyone beyond the fifth row. In such cases why bother to show anything at all? In this day of photocopying machines that enlarge, this flaw is particularly inexcusable.

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