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Report No. 10190-KO

STAFF APPRAISAL REPORT

KOREA

SCIENCE EDUCATION AND LIBRARIES COMPUTERIZATION PROJECT

MARCH 20, 1992

Country Department I
East Asia and Pacific Regional Office

CURRENCY EQUIVALENTS

Currency Unit - Korean Won (W)

US$1.00 = W730
(November 1991)

WEIGHTS AND MEASURES

Metric System

FISCAL YEAR

January 1 - December 31

ACADEMIC YEAR

March - February

ABBREVIATIONS

BE	- Board of Education
CULA	- Committee for University Library Automation
EFB	- Education Facilities Bureau
ELPD	- Education Loan Projects Division
EMD	- Equipment Maintenance Division
GHS	- General High School
ICB	- International Competitive Bidding
KCUE	- Korea Council for University Education
KEDI	- Korea Educational Development Institute
KIST	- Korea Institute of Science and Technology
MOE	- Ministry of Education
O&M	- Operations and Maintenance
OSROK	- Office of Supply, Republic of Korea
PCC	- Project Coordinating Committee
PCR	- Project Completion Report
PPAR	- Project Performance Audit Report
R&D	- Research & Development
SEC	- Science Education Center
SNU	- Seoul National University
STEB	- Science and Technology Education Bureau
SOE	- Statements of Expenditure
TAP	- Technology Advancement Project
TRC	- Technical Repair Center
UEO	- University Education Office
VHS	- Vocational High School
VTI	- Vocational Training Institute

KOREA

SCIENCE EDUCATION AND LIBRARIES COMPUTERIZATION PROJECT

Table of Contents

The report is based on the findings of a preappraisal mission which visited Korea during July-August 1991 and an appraisal mission consisting of Mr. W.E. Rees (mission leader), Ms. I.B. Travis (computer specialist) and Messrs. S.Z. Sung and V.G. Desa (consultants), which visited Korea during November 1991. Peer reviewers were Messrs. A. Aime (EA3PH) and E. Thulstrup (PHREE). The documents were reviewed by Messrs. Bradley O. Babson, Chief, EA1PH, and Callisto Madavo, Director, EA1.

Table of Contents (Cont'd)

KOREA

SCIENCE EDUCATION AND LIBRARIES COMPUTERIZATION PROJECT

Loan and Project Summary

Borrower	:	Republic of Korea
Beneficiary	:	Not applicable
Amount	:	US$50 million equivalent
Terms		Repayable in 15 years including 5 years of grace at the Bank's standard variable interest rate.
Project Description	:	The overall objective of the project is to assist in improving the quality of basic science education and to provide a more effective flow of information between university libraries which service teaching and research. The project would include specialized equipment to be financed by the Bank (US$50.0 million excluding contingencies) to be allocated to support: (a) secondary science education centers (US$5.0 million); (b) undergraduate science education (US$25.0 million); and (c) a university library network (US$20.0 million). The Government would finance complementary inputs related to making the equipment operational and maintaining it thereafter, namely local transportation and installation costs, O&M and consumables. The Government would also finance staff training connected with libraries' computerization.
Benefits and Risks	:	The project would result in strengthened science programs in the secondary schools and universities. This would improve the quality of training of scientists and engineers which in turn would help to strengthen Korea's policy of high-technology industrialization. The project would also assist in improving information flows in the universities thereby increasing the effectiveness of teaching and research. A possible project risk concerns the ability of local authorities to design and implement the innovative library network component. This risk would be reduced through the operation of appropriate coordinating and technical bodies.

Project Costs:

	Local	Foreign	Total
	(US$ million)		
Science Education Centers	1.7	5.2	6.9
Undergraduate Science Education	8.7	26.0	34.7
Library Network	7.3	20.8	28.1
Baseline Cost	17.7	52.0	69.7
Contingencies			
Physical	0.9	2.6	3.5
Price increase	2.6	5.9	8.5
Subtotal	3.5	8.5	12.0
Total Project Cost /a	21.2	60.5	81.7

Financing Plan:	Local	Foreign	Total
	(US$ million)		
Government	21.2	10.5	31.7
IBRD	-	50.0	50.0
Total	21.2	60.5	81.7

Estimated Disbursements:

Bank FY	1993	1994	1995	1996	1997	1998
Annual	4.0	10.0	18.0	13.0	4.0	1.0
Cumulative	4.0	14.0	32.0	45.0	49.0	50.0

/a Does not include duties, taxes and fees estimated at US$4.3 million.

Economic Rate of Return: Not applicable.

Map: IBRD No. 23475

KOREA

SCIENCE EDUCATION AND LIBRARIES COMPUTERIZATION PROJECT

I. SCIENCE EDUCATION IN KOREA

A. Introduction

1.1 Underlying Korea's successful industrial growth in recent years has been the continuous restructuring of industry towards high technology-intensive production. Fundamental to this shift has been the rapid growth of an industrial research and development (R&D) capacity, and the expansion of training of scientists and engineers. Expenditures on R&D have increased rapidly over the last two decades through expansion of the network of public sector research institutes, the growth of university research facilities and the establishment of private sector research institutes in response to government-provided financial incentives. R&D expenditures, which were 0.7% of national income in 1977, had risen to 2.4% by 1989. It is planned that these proportions will increase to 3% by 1991 and 5% by 2001. Underlying these trends in R&D expenditures has been the expansion of training of scientists and engineers in the universities. Particular emphasis was given to expanding graduate programs in recognition of the rapidly rising technology intensiveness of industry in the 1980s. In this period, enrollments in graduate programs tripled and the output of graduates increased 4.6 times. At the undergraduate level, the 1980s saw a moderating of rapid enrollment increases as more emphasis was placed on quality improvements (para. 1.12).

1.2 Although the current level of Korea's R&D expenditures as a proportion of national income compares favorably with the industrialized countries, its endowment of R&D personnel lags well behind these countries. In spite of the rapid expansion of graduates from science and technology programs in recent years, the number of Korean researchers per ten thousand population is little more than one-third the number in Japan and the United States. The Government plans to raise the ratio of scientists and engineers from 13 per 10,000 population in 1986 to 30 per 10,000 by 2001, a level comparable to the US and Japan in 1985. To achieve this goal, Korea will need to employ about 150,000 scientists and engineers by 2001 compared with 56,000 in employment in 1988. Of these about 10% or 15,000 will have doctorates and will be expected to provide leadership in advanced R&D activities. Given current output trends from science and engineering programs, the target is feasible.

1.3 The foregoing makes clear that Korea has embarked on an ambitious path to expanded R&D capacity and the training of the necessary scientists and engineers to support this expansion. However, this represents only the apex of the science education pyramid. A rapidly modernizing country such as Korea needs a broad base of scientific literacy within the population in order to cope with a constantly changing technological environment. This requires the introduction of science courses early in the educational process and adequate opportunities for those who wish to specialize in science subjects as they progress through the education system. In Korea, science is taught as a

general subject in the primary and middle schools (grades 1-9). In high school (grades 10-12) science is taught in four subjects (physics, chemistry, biology and earth science) and the amount of science education received by each individual student will depend upon the major being pursued (para. 1.5). In the universities, undergraduate courses are available in a wide range of subjects in the four fields of natural science. Students may major in science, take a minor or pursue the requisite foundation science courses necessary for an engineering degree.

B. Science Education at the Secondary Level

1.4 Secondary education in Korea comprises two streams - general and vocational - both of three years' duration (grades 10-12). General high schools (GHSs) are academically oriented and aim largely at preparation for higher education. Vocational high schools (VHSs) aim at continuing general education to grade 12 while at the same time providing sufficient vocational education to permit graduates to find employment in their fields of specialization. In 1990, enrollments in general high schools were about 1,473,000 and in the vocational high schools, around 811,000.1/ Entry to both streams is based on scholastic record in middle school, interviews and the results of entry tests.

1.5 Curriculum. The first year (grade 10) of the GHS curriculum is common to all students and is built around a core of language, social studies, mathematics and science. In grade 11, students select one of three majors - humanities, science or vocational - the latter being aimed largely at entry to the two-year post-secondary vocational colleges.2/ Science is taught as part of all three majors but with different levels of emphasis. Science majors study physics, chemistry and either biology or earth science and together these subjects account for about 20% of the curriculum. Humanities and vocational majors study science as an integrated subject which accounts for about 8% of the curriculum. Science courses are available at two levels, general and advanced. The latter are mandatory for students intending to study science or engineering at the university level.

1.6 The science curriculum is divided into 30% practical work and 70% theory. In the past, the theory part was criticized as bearing little relevance to students' everyday lives. Subsequent curriculum revisions in the 1980s introduced many new topics such as pollution, energy conservation,

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1/ There were also 6 science high schools with total enrollments of 744 providing education for scientifically gifted students.

2/ There is a considerable difference in the balance between general and vocational subjects within the curricula of the VHS and the vocational major in the GHS. In the former the subject allocations are: general 35%, vocational 65%; in the GHSs the figures are reversed i.e. general 65%, vocational 35%. The structure of enrollments by major is: humanities 54%, science 42% and vocational 4%.

preservation of natural habitats etc. The teaching of the practical aspects of the curriculum also suffered from problems related to lack of equipment, shortage of teachers resulting in classes too large to involve students in meaningful experimentation, and the nature of university entrance exams. The latter emphasized rote learning of facts and principles and pursuing practical work had little relevance to success in university entrance exams. The result was neglect of practical, experimental work. The above situation has improved considerably over the past decade. Equipment provision has improved (assisted under Ln. 2427-KO), the supply of science teachers has increased substantially 3/ and reform of university entrance requirements has reduced the importance of the entrance exam and broadened selection criteria to include high school grades and performance in personal interviews.

1.7 Curriculum revision and the publication of textbooks conforming to the revised curriculum are closely coordinated by MOE. The curriculum for the general high schools is revised periodically (roughly every 5-7 years) and the latest revision (including science) was completed in 1990. Direct responsibility for curriculum revision lies with two types of committees - one concerned with course content and the other with the structure of the curriculum in terms of the numbers of mandatory and elective subjects, number of weekly class periods assigned to each, etc. The committee on curriculum structure comprises 20-30 members, mainly teachers and university academics, with strong representation from the local boards of education (BEs). This committee's work is scheduled for completion before work on course content begins. There is a course content committee for each subject and each committee comprises 20-30 teachers and academics who are experts in particular subject areas. The actual drafting of curriculum revisions is delegated to a subcommittee of 5 members which takes into account the views of a broad sample of teachers and employers. For science subjects, specific experiments are prescribed and the minimum percentage of time to be allocated to laboratory experiments is mandated, currently about 15-30% of total course time. Curriculum review is spread over about 3 years followed by two years of testing the proposed changes in selected schools. The final curriculum is introduced after about 5 years and is mandatory in all schools. Textbooks reflecting curriculum changes are prepared by private publishers under the general guidance of MOE.

1.8 Equipment. Each science subject has a standard equipment list which specifies the numbers and types of equipment necessary to teach the curriculum for each subject. The lists are revised periodically to reflect changes in the curricula. These revisions were, until recently, the responsibility of the Equipment Management Division (EMD) within the Education Facilities Bureau (EFB) of MOE. The EMD organized committees of 5-10 science teachers and academics to review and update the standard lists. However, following the 1990 curriculum revision, responsibility for reviewing standard lists was given to the Korea Education Development Institute (KEDI). The same committee approach is being followed by KEDI. Responsibility for procuring the laboratory equipment specified in the standard lists lies with the local BEs.

3/ The stock of science teachers increased by nearly 90% during 1982-90.

The level of equipment provision varies considerably between schools but in general, provision falls well below standard requirement. It is estimated that the average level of provision nationally is only about 50%. To augment funds available for equipment purchases, MOE has recently established the Science Promotion Fund to secure donations from private corporations. The Fund's goal was Won 5 billion and this has been achieved. Routine repair and maintenance of science equipment is the responsibility of science teachers. They receive 60 hours of instruction in equipment maintenance and repair as mandated by the EMD. The latter also issues guidelines and regulations on repair and maintenance including the requirement for semi-annual inventories of equipment. These reports pinpoint equipment in need of repair. More complex repairs are carried out in the science education centers while equipment requiring major repair is sent to Seoul Industrial University.

1.9 Teachers. There were nearly 6,850 teachers of science in the general high schools in 1990 specializing in biology (29%), chemistry (26%), physics (24%) and earth science (21%). All science teachers are graduates of colleges of education or departments of education in universities and are licensed on graduation as grade 2 teachers. After 5 years of teaching experience, teachers are allowed to enroll in in-service training programs. After completing 180 hours of such training, teachers are promoted to grade 1, the highest non-administrative grade for teachers. In addition to training for promotion, science teachers undergo 60 hours of training in relation to curriculum revision to become acquainted with the changes and to master any new experiments required by the curriculum. Both types of training are provided for science teachers in the science education centers (SECs) and in colleges and universities. Because of the requirements for promotion and curriculum revision, in-service training programs are substantial. The 34,000 general high school teachers undertook an average of nearly two in-service training programs per person in 1990. Although separate data are not available for science teachers, it can be assumed that they gained substantially from in-service training.

1.10 Student Assessment. Student progress in science subjects is monitored regularly through written tests and exams. Students take written tests monthly in core subjects and sit for two major examinations each semester. The latter form part of the students' records. Although the monthly tests may be of a multiple choice type, the exams take the problem solving approach. A national university entrance exam is held in January each year for high school seniors. In the past, student monitoring in science courses tended to neglect the testing of experimental knowledge largely because the university entrance exams were oriented towards theoretical knowledge. However, with the change in the structure of university entrance exams (supported under Ln. 2427-KO), to include, inter alia, more emphasis on students' high school records and greater prominence for experimental knowledge, high school science teaching is becoming more focused on experimental work. Hence the need for better equipped science laboratories and the need to strengthen the role of the science education centers in improving their capacity to raise the quality of experimental courses in high school science.

1.11 Science Education Centers. A science education center has been established under each of the 15 local boards of education to support the teaching of science education. The focus of the SECs is mainly at the secondary level although some support is also given to primary science education. In support of secondary science teaching, the SECs provide in-service training for high school science teachers and experimental courses for senior secondary students, in areas where such courses are more efficiently undertaken in centralized locations rather than in individual high schools. The SECs are also responsible for the preparation of teaching materials. The SECs are well-endowed with teaching staff but equipment provision is inadequate to teach the full range of laboratory courses required by the science curriculum. The level of equipment provision at present is only about 60% of the standard requirement in the SECs. The SECs are funded entirely by MOE but are under the operational control of the local boards of education. The BEs are responsible for appointing the directors and other staff of the SECs. The directors are usually former high school principals with science majors. To ensure that SEC directors are kept up-to-date on new teaching materials and other issues, they meet annually in conference under the auspices of MOE. During 1990, 16,300 individual in-service training sessions were held in the SECs. About 220,000 science students passed through experimental and laboratory courses in the SECs while 43,000 attended computer training. In the field of teaching materials development, the SECs produced 32,000 experimental guidebooks and over 11,000 sets of science materials.

C. Science Education at the University Level

1.12 Enrollment. Enrollment in undergraduate programs in the natural sciences 4/ in Korea's 107 universities and colleges was around 420,000 in 1990 or about 40% of total undergraduate enrollment. The pattern of enrollment in recent years reflects changing policies regarding the development of the university system. In the seventies and early eighties enrollment in natural science programs expanded rapidly as Korea sought to enlarge its stock of scientific and technological manpower to support the shift to technology-intensive industry. During this period, undergraduate enrollment in natural science programs increased at 29% p.a. However, this rapid expansion was achieved at the expense of some loss of quality and the eighties saw a reduction in enrollment growth and a shift to emphasizing higher standards. Enrollments in natural science programs increased at only about 3% p.a. during 1982-90. Within this trend, enrollment in basic sciences (being assisted under the proposed project) showed a similar pattern. A growth rate of around 26% p.a. through the seventies was reduced to about 6% p.a. in the eighties as quality improvement took priority over quantitative expansion.

4/ The natural sciences comprise the basic sciences (mathematics, physics, chemistry, biology, earth science), engineering, agriculture, forestry, fisheries and health.

1.13 Women are under-represented in natural science programs in Korean universities. In 1990, women accounted for 19% of enrollments in natural science and this proportion reflects the traditional reluctance of women to enroll in science-related programs.5/ No discriminatory practices exist which would discourage women from enrolling in science programs and the present enrollment pattern is largely the result of the exercise of individual preferences. However, if engineering (where female enrollment is only 6%) is excluded, women account for about 36% of other science programs. Moreover, present trends favor a continued increase in the proportion of women in science programs. Whereas male enrollment increased at less than 2% p.a. during 1982-90, the female enrollment rate rose at over 6% p.a. in the same period. In the 18 national universities to be assisted under the proposed project, female enrollment in natural science programs is 45%.

1.14 Academic Staffing. One of the consequences of the rapid expansion of enrollments in natural sciences in the seventies and early eighties was a rising student/staff ratio as enrollments outran the supply of qualified faculty. The situation improved in the eighties as enrollments slowed and faculty recruitment expanded in line with the priority for quality improvement. This has led to an improving student/staff ratio although the present figure is still high by most university standards. The overall ratio in the natural sciences in 1990 was 26:1, an improvement over the 36:1 recorded in 1982. The ratios vary considerably between fields of specialization from 8:1 in the health sciences to 44:1 in engineering. The ratio for basic science was 23:1 in 1990. An improvement in the quality of faculty, at least in terms of the numbers holding doctorates, is also evident. Currently about 70% of faculty have a doctorate compared with 29% in 1982. The expansion of faculty has also reduced teaching loads with contact hours now averaging about 11 hours per week.

1.15 Evaluation of Science Programs. The shift towards emphasis on quality improvement in recent years has reinforced the need for sound evaluation of programs to ensure increasing standards in undergraduate science programs. Consistent with the self-governing nature of the universities, evaluation of programs has relied heavily on internal self-evaluation. However to strengthen this process and to make it more systematic among the 107 universities and colleges, the Korea Council for University Education (KCUE) has been given a major role in evaluation. The KCUE's University Evaluation Project calls for a five year cycle of evaluation and implementation. The first year will be for self-evaluation by individual institutions followed by on-site visits from KCUE evaluation teams. The following three years will be devoted to reviewing evaluation priorities and implementing the necessary actions. Self-evaluation is already well advanced and has already been completed in 92 universities. KCUE on-site teams are focussing on academic program evaluation and have completed reports for nursing, librarianship, computer engineering and physics. The evaluation process has been strengthened by the preparation of high-quality evaluation

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5/ Women accounted for 28% of total undergraduate enrollment in 1990. In humanities the proportion was 47%.

manuals and guidebooks which focus on the self-evaluation of key areas such as curriculum, student enrollments, faculty, administration and finance, facilities and equipment. In the longer term, when a sound basis of institutional evaluation has been established, it will help to strengthen the accreditation system established under Ln. 2427-KO.

1.16 Student Assessment. The academic progress of students in science programs is assessed during each semester of study and on completion of the course requirements for the award of a bachelor of science degree. There is a great deal of departmental autonomy practiced in the semester assessments. The majority of universities hold two examinations per semester, one at mid-term and the other at the end of the semester. Examinations may be either essay type, multiple choice or a combination of both. They are graded by the faculty teaching the course. Success in laboratory sessions and practical training is usually assessed on the basis of performance in actual experimental or practical tasks. The requirements for the award of a bachelor's degree are defined by law. Candidates must have successfully completed 140 academic credits and pass the prescribed examinations. The examination requirement can be met through the submission of a dissertation, a report on a practical experiment or by passing a comprehensive graduate examination. The examination and the requirements for obtaining a pass are set out in detail under a ministerial decree. The approach to student assessment varies widely between and within universities. Within universities, semester assessment may vary between departments and/or between years. For example, at Pusan National University, freshmen have mixed (essay/multiple choice) assessments while juniors are subject only to essay-type assessments. In Seoul National University, the physics department uses the essay and the mathematics department the mixed assessment. For graduation at Pusan, geology students are assessed on a dissertation while physics students must complete a comprehensive examination. This eclectic approach has the advantage of flexibility which allows assessment procedures to be matched against the particular needs of departments and programs. However the approach does raise the question of how to maintain some degree of uniformity of examination standards. This issue has been recognized and is being addressed as part of KCUE's evaluation activity.

1.17 Equipment. The Ministry of Education maintains specialist committees which identify the laboratory equipment required for each of the undergraduate laboratory courses in the university departments of natural science. MOE publishes standard equipment lists for each course which are revised as curricula change. The latest revisions were completed in 1987 but prices of equipment items are updated annually. Each department maintains a list of equipment holdings, including the cost of items and the source of acquisition. Identification of equipment needs is based on a comparison of acquisitions with standard lists. Routine equipment repairs are carried out by laboratory staff while equipment requiring major repairs is handled by the Seoul Industrial University.

D. Library Network

1.18 The growth of Korea's universities in recent years has been accompanied by a similar expansion of information requirements to service

teaching, research and administration. The major repositories of such information are the university libraries. The 107 universities and colleges have 159 libraries with a total collection of around 23.5 million items. The collection is increasing at nearly 10% p.a. and as an indicator of the scale of activity, nearly 17.9 million book loans were made in 1989. The size of, and level of activity in, the university libraries are such that automation through the introduction of computers has become an urgent requirement. No university has a computer dedicated to library use and only four universities are using their mainframe computers for library work. Such automated activity (mainly cataloguing) that exists is handled by personal computers 6/. There is therefore a priority need for a computerized library network to strengthen and integrate cooperative efforts between libraries. These include shared cataloguing, inter-library loans, improved access to research databases, etc.. Regarding the latter, a computerized network would provide a link between the universities and the science and technology database maintained by KIST.

1.19 In response to the above situation, the Government plans to link all the university and college libraries with a computerized network. The first stage of the network's development will be built around ten leading national universities and the Social Science Information Center of KEDI. The lead institution will be Seoul National University (SNU), which will establish a main center linked to local centers at KEDI and at nine national universities in the provinces.7/ SNU would eventually maintain a union catalogue of the holdings of all the university libraries in Korea and make available selected foreign scientific and technical databases. The collections of the 11 libraries number 4.7 million items and serve 18,500 staff and 175,000 students. Total professional library staff is 551. Software for the network is being developed through a joint effort between SNU and a local private firm at a cost of about US$1.0 million. SNU carried out an extensive study of university library software in the United States, Canada and Japan and concluded that they could not buy an off-the-shelf package that would suit their needs primarily because of the difficulties in accommodating the Chinese (Han) character set. Consequently, SNU entered into a joint venture to

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6/ More advanced automation exists elsewhere. There is an automated network of scientific and technical institute libraries with administrative headquarters at the Korea Institute for Science and Technology (KIST) and a computing center in the Taejon area. The Medical Library Association publishes a union catalog of serials and has a strong interlibrary lending program, while the Central National Library provides a database of all Korean publications, which they are preparing to make available online nationwide, both through a network for public libraries under the Ministry of Culture and through the university library network when it is established.

7/ All the other university and college libraries will ultimately be linked through the nine local centers. In the first stage 15 public universities and 11 teachers' colleges will be linked to the local centers. Thus the first stage will cover 37 institutions.

produce the software following local competitive bidding to secure a partner. The software is based on an existing Canadian system and is designed to be utilized with Tandem hardware.

1.20 Overall responsibility for network development lies with the Committee for University Library Automation. The CULA is made up of the directors of the 10 university libraries who are senior academics on two-year appointments. CULA is responsible for formulating the long-term plan for network development and also for the annual plans. It is also responsible for evaluating achievements under the annual plans and for procuring financing for the plans. Operating under the direction of CULA is the Working Group for University Library Automation which comprises the 10 chief librarians of the university libraries. The Working Group is responsible for the execution of the annual plans and for addressing technical issues in network development. Special subcommittees will be established to handle major technical issues. A subcommittee on cataloguing was recently established and has begun work on interlibrary cataloguing issues. In combination, these bodies provide overall policy and planning capacity together with technical expertise in implementation. They will ensure that long-term plans for completing network development are achieved in a technically sound manner. In view of the rapid change in technology, they will also ensure that the network is kept technically up-to-date.

E. Bank's Experience in Education

1.21 The Bank has assisted Korea's technology development efforts through substantial support for the development of technical and scientific education and research.8/ Bank lending has been consistent with Korea's needs and priorities in education and has closely paralleled the increasing sophistication of Korean industry. It was recognized that the restructuring of industry towards more skill-intensive, high-technology production would require the continuous expansion and upgrading of technical skills. Thus as industry developed towards greater skill-intensiveness, Bank assistance to education moved from support for craftsman and technician training through professional engineering education to graduate engineering programs and associated research activities.

1.22 The Bank's initial involvement in the sector under four loans/credits, focused on the development of vocational and technical education at the secondary and post-secondary levels to strengthen the base of the system for producing technical personnel. Project performance audit reports (PPARs) for these projects concluded that they were in general well-conceived and successfully implemented. The first education project in Korea (Cr. 151-KO) supported the expansion of vocational high schools, junior technical colleges and teacher training. It also financed technical assistance and fellowships

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8/ The Bank has also provided major support to technology development through directly financing R&D programs, strengthening intermediaries which finance R&D and providing credit for industrial development in general.

to strengthen the planning and administration of vocational and technical education. The PPAR for the credit (Report No. 1801-KO, November 22, 1977) concluded that physical implementation was satisfactory but that some delays were experienced in recruiting and utilizing the experts under the technical assistance component. The latter could have been overcome by more careful scheduling and a clearer definition of the experts' functions.

1.23 The second education project (Ln. 906/Cr. 394-KO) financed equipment for vocational high schools, junior technical colleges and undergraduate programs in science, engineering and education. The PPAR for the project (Report No. 4509, May 24, 1983) concluded that the project was implemented substantially as planned but with some delays due to over-optimistic scheduling. The third education project (Ln. 1096-KO) continued to support expansion and quality improvement in vocational high schools and junior colleges and for vocational training institutes (VTIs) under the Ministry of Labor. The project was implemented successfully and demonstrated the growing experience and competence of local project staff. The fourth education project (Ln. 1474-KO) supported a further expansion of VTIs and expansion and improvement of instructor training. The project completion report (PCR) for the project (Report No. 5516, March 8, 1985) concluded that the project was well designed, implemented efficiently and judged the project to be an excellent example of Bank/Borrower cooperation. It is reasonable to conclude that the first four projects demonstrated that the increased competence of local authorities led to improved project design and implementation. Project experience also demonstrated that there was a need to take a broader view of sectoral policies and issues after the implementation of four conventional projects. This was taken up in the two subsequent operations which were policy-oriented sector loans.

1.24 The first education sector loan (Ln. 1800-KO) concentrated on upgrading junior technical colleges and university colleges of engineering and management through the supply of equipment, staff development and institutional improvements in curriculum development, manpower planning, equipment maintenance and academic accreditation. The PPAR for the loan (Report No. 7252, May 24, 1988) indicates that the major lessons learned were: (a) a stable and responsible sector management agency was the key to successful implementation of the sector program; (b) the sector approach led to a quicker and more sustainable development of institutional capabilities; and (c) the additional time required for preparation was repaid in terms of more efficient implementation.9/

1.25 The second education sector loan (Ln. 2427-KO), which incorporated these lessons, assisted in supporting improvements in graduate education in science and engineering, upgrading secondary school and college science programs, expanding graduate research programs, improving sector management

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9/ The Bank's positive role in Korea's education sector under the first five lending operations is documented in the OED report titled Review of the Impact of World Bank Lending for Educational Development in Korea (Report No. 5950; December 4, 1985).

and manpower monitoring and strengthening the financial base of private educational institutions. Implementation of the loan was satisfactory and it closed on schedule on June 30, 1989. The PCR for the loan concludes that its objectives were largely met. Policy and institutional improvements of particular relevance to science education were introduced in relation to accreditation of colleges of natural science and science education departments, upgrading and expanding staffing of these institutions and the planning of facilities and equipment; at the secondary level, a new experimentation-oriented science curriculum was introduced, a system to monitor student achievement in science developed, new examination and college admission procedures introduced and science teachers upgraded through in-service training.

1.26 Following these education projects the Bank turned its attention to supporting research activities in the universities and in the national research institutes under three Technology Advancement Projects (TAPs) and the Universities Science and Technology Research Project. However, the first two TAPs also contained a component assisting science and engineering education. Ln. 3037-KO assisted in improving the quality of science and engineering education at the Korea Institute of Technology, a center of excellence for the under-graduate teaching of gifted students in science and mathematics. Ln. 3202-KO supported quality improvement at the Korea Advanced Institute of Science and Technology, the leading graduate school in science and engineering. The Universities Science and Technology Research Project (Ln. 3203-KO), although focusing exclusively on research will, nevertheless, have an indirect impact on teaching because of the close link between the research undertaken by faculty and their teaching responsibilities. In the recently-approved Vocational Education Project (Ln. 3314-KO), the Bank is reverting to assistance to vocational training in recognition of the continuing need for craftsman training to keep pace with the increasingly complex skill requirements of the labor market.

II. THE PROJECT

A. Origin of the Project

2.1 The Government included the project in its CY91 list of projects suitable for external financing and formally asked the Bank for assistance in November 1990. Most of the preparation work was completed by the Government according to guidelines formulated by the Bank. The project was preappraised in July-August 1991 and appraised in November 1991.

B. Project Rationale, Objectives and Scope

2.2 Improving the quality of basic science education is directly linked to the quality of scientists and engineers produced by Korea's universities and colleges. The impact is cumulative. Improved science education in the secondary schools leads to higher quality science education in the foundation science programs in the early years of college. This in turn strengthens the quality of science degrees and also engineering degrees, which are built on a foundation of basic science. The proposed project provides the opportunity for the Bank to continue its work in strengthening basic science education in Korea, introduced under Ln. 2427-KO. Furthermore, the project was designed within a sound policy framework for science education which was strengthened under Ln. 2427-KO.

2.3 The rapid growth of enrollments in science and engineering programs and the upgrading of these, accompanied by similar trends in all major fields of study in Korea's universities, have led to an information explosion which is beyond the capacity of the present university library system to handle. Quicker and broader access to information is urgently needed to handle the rapidly growing demands of students, faculty and researchers. A long-term plan for the interlinking of university libraries in Korea has been prepared and the Government has requested the Bank to assist in the implementation of the first stage. The proposed project, which would finance the supply of computer and related hardware, has also provided an opportunity for the Bank to bring value added to network development. As part of project design, the Bank has provided expertise to review the adequacy of the first stage plan and also to review hardware requirements and the appropriateness of associated software. The Bank has also reviewed network design to ensure that it is technically sound and that institutional arrangements for long-term network development are appropriate. The latter include advice on the development of criteria to monitor progress in long-term network development. Bank supervision of the project would provide expertise to review regularly the technical and institutional aspects of network development.

2.4 The broad aim of the project is to assist in improving the quality of basic science education and to provide a more effective flow of information between university libraries which service teaching and research. More specifically, the project would assist in: (a) raising the quality of science programs offered in the secondary schools and in the basic science programs in the universities in order to strengthen the quality of science and engineering

degrees and improving scientific literacy in general; and (b) establishing an interlibrary network linking 37 institutions to enhance the access to information of students, faculty and researchers.

C. Project Design and Description

2.5 The project would finance equipment estimated to cost US$50.0 million, excluding contingencies. This amount has already been determined by the Government and is fixed within the foreign borrowing program. Bank-financed equipment would be allocated to the science education centers (US$5.0 million, excluding contingencies), undergraduate science education (US$25.0 million) and the library network (US$20.0 million). The equipment forms the core of the project but in order to ensure that it is utilized effectively, complementary inputs (US$19.4 million, excluding contingencies) must also be supplied. These would be financed by the Government and cover local transportation and installation of equipment, O&M and consumable materials. The Government would finance all contingencies related to these components and to the equipment and also finance computer training related to the establishment of the library network (US$0.3 million excluding contingencies).

2.6 Equipment to be procured under the project in support of improving the quality of secondary science education (US$5.0 million, excluding contingencies) would be located in 13 science education centers which have permanent facilities and in two centers with such facilities under development. Each existing SEC has partially equipped science laboratories and therefore, at present, cannot carry out the full range of experimental courses required by the science curriculum. The equipment to be provided under the project, would permit a range of new experimental courses to be offered for grades 10 and 11 thus fulfilling curriculum requirements.10/ The director of each SEC would develop the courses in consultation with the principals of the high schools within his municipality or province. The duration of each course and the number of times each course would be offered per week would be determined by each SEC director. Directors would send to the board of education and MOE for approval, a brief description of the content of each proposed course together with information on duration and frequency and a list of required equipment. All items of equipment for the courses offered in the SECs to be financed under the proposed project, together with their specifications, would be taken from the standard equipment lists for high school science education courses already prepared by MOE. Loan funds would be allocated to each SEC on the basis of agreed criteria which would include: (a) the number of grade 10 and grade 11 natural science majors in the municipality or province; (b) the availability and condition of existing equipment in each SEC; and (c) the quality of proposed courses and relevance to the science curriculum. Guidelines have been agreed for the development of the practical science courses in the SECs and the identification and supply of

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10/ It is estimated that equipment provision in the SECs is at present around 60% of the standard list requirements. The proposed project would raise this proportion to about 80%.

associated equipment. During negotiations, the Government agreed that the development of the courses and procurement of related equipment would be in accordance with guidelines acceptable to the Bank.

2.7 Equipment to be procured under the project in support of improving undergraduate science education (US$25.0 million, excluding contingencies) would be allocated to the 18 national universities with colleges of natural science. Of this amount, US$15.0 million would be utilized to raise the provision of departmental undergraduate equipment to at least 70% of MOE standards. To ensure that the focus of equipment procurement is on undergraduate science education rather than on the equipment requirements of research programs, the Government would be asked, during negotiations, to agree to a maximum unit price of equipment of US$50,000 unless otherwise agreed with the Bank. An amount of US$7.0 million would be allocated to support the introduction of advanced laboratory courses in the senior year of undergraduate studies. Most of the equipment would be located in joint equipment centers and institutes of basic science supplementing the highly expensive equipment being procured under Ln. 3203-KO. To ensure that there is no duplication of expensive equipment items, the Government agreed, during negotiations, to a maximum unit price of equipment of US$100,000 unless otherwise agreed with the Bank. The remaining US$3.0 million would be allocated for the supply of equipment to encourage full-time lecturers and assistant professors to remain on the teaching faculties. At least two faculty members from each of the participating universities would benefit from this program. This would encourage more junior faculty members to remain in teaching rather than move to industry where there is strong demand for science/technology graduates.

2.8 Equipment to be procured to assist in the development of the library network would include 11 mainframe computers (1 x 128 mb and 10 x 32 mb) and peripherals to link the libraries of the main center at SNU to KEDI and to the nine local university library centers. This equipment (estimated cost US$8.0 million, excluding contingencies) would permit each library center to keep a master copy of the records of its members to facilitate such functions as shared cataloguing and interlibrary loans. The centers would also make available scientific and technical databases and support other automated library functions such as circulation and serials check-in. Equipment (estimated cost US$12.0 million, excluding contingencies) would also be procured to provide smaller computer systems for network participation and local library automation in the 15 other universities and 11 teachers' colleges in the network. The allocation of loan funds among the several types of institution would be as follows: main center (US$6.3 million), 10 local centers (US$8.9 million), 15 provincial universities (US$4.4 million) and 11 teachers' colleges (US$0.4 million). Computer-related staff training (estimated cost US$0.3 million, excluding contingencies) would be included in the project and financed by the Government. Technical oversight of long-term network development would be undertaken by the Committee for University Library Automation which is operating under terms of reference acceptable to the Bank.

III. PROJECT COSTS, FINANCING AND IMPLEMENTATION

A. Costs

3.1 The total cost of the project is estimated at US$81.7 million equivalent net of duties and taxes. The estimated cost by project component is summarized in Table 3.1 and by category of expenditure in Table 3.2. Detailed costs by component and category are given in Annex 2 and project expenditure by year and recipient in Annex 3.

Table 3.1: SUMMARY OF PROJECT COSTS BY COMPONENT

	Won Billion			US$ Million			Foreign as % of Total
	Local	Foreign	Total	Local	Foreign	Total	
Science Education Centers	1.3	3.8	5.1	1.7	5.2	6.9	75
Undergraduate Science Education	6.4	19.0	25.4	8.7	26.0	34.7	75
Library Network	5.3	15.2	20.5	7.3	20.8	28.1	74
Baseline cost	13.0	38.0	51.0	17.7	52.0	69.7	75
Contingencies							
Physical	0.6	1.9	2.5	0.9	2.6	3.5	74
Price increase	1.9	4.3	6.2	2.6	5.9	8.5	69
Subtotal	2.5	6.2	8.7	3.5	8.5	12.0	71
Total Project Cost /a	15.5	44.2	59.7	21.2	60.5	81.7	74

/a Does not include duties, taxes and fees estimated at US$4.3 million.

Table 3.2: SUMMARY OF PROJECT COSTS BY CATEGORY OF EXPENDITURE

	Won Billion			US$ Million			Foreign as % of Total
	Local	Foreign	Total	Local	Foreign	Total	
Equipment	-	36.5	36.5	-	50.0	50.0	100
Equipment transportation and installation	2.0	0.2	2.2	2.7	0.3	3.0	10
Operations and maintenance	5.4	0.6	6.0	7.4	0.8	8.2	10
Consumable materials	5.4	0.6	6.0	7.4	0.8	8.2	10
Training	0.2	0.1	0.3	0.2	0.1	0.3	33
Baseline cost	13.0	38.0	51.0	17.7	52.0	69.7	75
Contingencies							
Physical	0.6	1.9	2.5	0.9	2.6	3.5	74
Price increase	1.9	4.3	6.2	2.6	5.9	8.5	69
Subtotal	2.5	6.2	8.7	3.5	8.5	12.0	71
Total project cost	15.5	44.2	59.7	21.2	60.5	81.7	74

3.2 Base costs are estimated at November 1991 prices. Equipment costs are estimated on the basis of master lists already drawn up and recent catalogue prices. Transportation and installation costs, the initial supply of consumables and the costs of operations and maintenance are based on recent experience in project institutions. Duties and taxes, allowing for exemptions, are estimated at US$4.3 million.

3.3 The contingency allowance of US$12.0 million (about 17% of baseline costs) includes contingencies for unforeseen physical conditions and for estimated price increases. Physical contingencies were estimated at 5% of baseline costs for training, equipment, transportation and installation of equipment, consumable materials and O&M expenditures. Price increase contingencies were calculated for both local and foreign costs in accordance with the following expected annual average price increase percentages: foreign cost, 3.9% in FY93 and thereafter and local cost, 5% p.a. throughout. Accordingly, aggregated price increases are estimated at about 12% of baseline costs plus physical contingencies.

3.4 The foreign exchange component of US$60.5 million (about 74% of total estimated project costs) has been calculated on the basis of the following foreign exchange percentages: equipment - 100%, transportation and installation - 10%, consumables - 10%, O&M - 10%, and training - 20%.

B. Financing

3.5 The proposed loan of US$50.0 million equivalent would finance about 83% of the estimated foreign exchange cost of the project or about 61% of total project costs net of duties and taxes. The Government would be responsible for the remaining 39% or US$31.7 million equivalent. The loan amount is limited to US$50.0 million by the foreign borrowing program and is therefore less than the foreign exchange cost of the project. The loan would finance 100% of the baseline cost of equipment with all contingencies to be financed by the government. The loan amount would be allocated as follows: science education centers, US$5.0 million; undergraduate science education, US$25.0 million; and the library network, US$20.0 million.

Table 3.3: FINANCING PLAN

Category of Expenditure	Government	IBRD	Total
	----------US$ million----------		
Equipment	-	50.0	50.0
Equipment transportation and installation	3.0	-	3.0
Operations and maintenance	8.2	-	8.2
Consumable materials	8.2	-	8.2
Training	0.3	-	0.3
Contingencies	12.0	-	12.0
Total	31.7	50.0	81.7

Recurrent Expenditures

3.6 When fully operational, the project would generate educational recurrent costs for consumable materials and O&M estimated at US$2.7 million p.a. This would be spread over 31 institutions thus averaging about US$87,000 per institution. These additional expenditures could be accommodated by the institutions without difficulty. Consumable materials and O&M costs related

to equipment for the library network are estimated to be about US$2.3 million p.a. and could be accommodated by the 37 component institutions of the library network.

C. Project Management and Implementation

3.7 Overall responsibility for project implementation would lie with the Education Facilities Bureau of MOE - an agency that has gained considerable experience in implementing Bank projects through its responsibility for earlier Bank operations. Physical aspects of the project would be handled within EFB by the Education Loan Projects Division (ELPD) including relations with the Office of Supply, Republic of Korea (OSROK) for equipment procurement. Educational aspects at the undergraduate level would be handled by the University Education Office (UEO) of MOE and at the secondary level by the Science and Technology Education Bureau (STEB) of MOE. The University Education Administration Division of UEO would provide the administrative linkage with the universities. The Science Education Division of STEB would provide similar linkage with the secondary science centers through the local boards of education. The Project Coordinating Committee (PCC), established for the Universities Science and Technology Research Project (Ln. 3203-KO) would also be responsible for general oversight of this project. The PCC would assist in coordination between participating bodies, provide policy advice on project-related matters and resolve major problems which might arise during project implementation. The libraries' computerization component would be the responsibility of UEO assisted by the Committee for University Library Automation, with the SNU Library as the primary focus of responsibility. CULA would oversee the design of the university library network, including determining overall needs for hardware and software, development of appropriate software, specifications of hardware and its compatibility with software, initial operation of library automation and maintenance of the system within the budget allowed by UOE. The project implementation schedule is shown in Annex 4.

3.8 The Education Loan Projects Division would be responsible for routine correspondence and reporting to the Bank, and for financial and disbursement matters. ELPD has played this role in previous Bank projects and is staffed with experienced personnel. The bulk of the work in equipment procurement would be undertaken by OSROK, which is highly experienced in procuring equipment under the Bank's international competitive bidding (ICB) procedures. On the basis of equipment lists and specifications provided by project institutions through ELPD, OSROK would prepare bidding documents, invite bids, evaluate them in conjunction with ELPD and the institutions and make contract awards with the agreement of the institutions. The institutions would be responsible for installation, initial testing and operation of the equipment, unless specified in the equipment contract that the supplier would perform these tasks. The institutions would also be responsible for maintenance and repair of the equipment including acquisition of spare parts, accessories and consumables, beyond the items and services initially supplied under the contract. The Bank would supervise the project twice yearly around March and September coinciding as far as possible with the preparation of the semi-annual progress reports (para. 3.15). Regional average coefficients would be applied for allocating resources to project supervision. Overall

implementation issues would be handled by the task manager with technical aspects being the responsibility of a technical educator. A specialist in library network development would assist in supervision as required.

Status of Project Preparation

3.9 The advanced stage of project preparation would allow implementation to commence immediately after loan signing. Project institutions have been identified and equipment lists and specifications prepared. Project management authorities have been identified and competent staff are available to handle implementation activities. Implementation arrangements, including those for coordination between project agencies, have been agreed.

Procurement

3.10 Procurement arrangements are shown in Table 3.4. About 85% of the equipment, including all contracts for mainframe computers, would be procured on the basis of ICB procedures in accordance with the Bank's guidelines. Equipment items in contracts valued at less than US$300,000 may be procured up to an aggregate limit of US$7.5 million through shopping procedures allowing for the comparison of quotations from at least three suppliers. Local equipment manufacturers would be extended a 15% preference margin, or the prevailing customs duties, whichever is the lower, on bid evaluation under ICB. Local transportation, operations and maintenance costs on equipment would be financed by the Government under local procedures. Installation costs and costs of consumables, if not included in the equipment contracts, would also be financed by the Government. Training would be financed by the Government under local procedures.

Table 3.4: SUMMARY OF PROPOSED PROCUREMENT ARRANGEMENTS

Category of expenditure	Procurement Method ICB	LCB	Other	NBF	Total cost including contingencies
	(US$ million)				
Equipment	49.4 (42.5)	-	8.7 (7.5)	-	58.1 (50.0)
Equipment transportation and installation	-	-	-	3.6 (0.0)	3.6 (0.0)
Operations and maintenance	-	-	-	9.8 (0.0)	9.8 (0.0)
Consumable materials	-	-	-	9.8 (0.0)	9.8 (0.0)
Training	-	-	-	0.4 (0.0)	0.4 (0.0)
Total	49.4 (42.5)	- -	8.7 (7.5)	23.6 (0.0)	81.7 (50.0)

Note: Figures in parentheses are the respective amounts financed by the Bank loan.
NBF: Not Bank-Financed.

3.11 Hardware for the library network would be divided into two groups:

(a) computers that would run the library network software along with the peripherals that are dependant upon the computer selected, such as disk drives; and

(b) hardware such as PCs, laser printers, multiplexers etc. that are not dependent, or at least much less so.

The latter items would be procured under ICB if the estimated cost of the contract is US$300,000 equivalent or more. Equipment under this category would be packaged, as far as possible, in contracts of US$300,000 equivalent or more. Contracts costing less than US$300,000 equivalent would be procured through shopping procedures allowing for the comparison of quotations from at least three suppliers. Hardware for the library network would be procured under ICB. Network software is being developed by SNU Library in partnership with a private firm under a contract awarded following LCB procedures. In order to ensure that equipment procurement is not restricted to the hardware

specified in the software currently under development, the invitation to bid for computer hardware under (a) above would allow bidders to offer one or both of the following options:

(i) hardware to support the existing network software, including the cost of porting it to the vendor's own hardware, if necessary; and

(ii) the vendor can propose alternative software that meets network software specifications and the hardware to run it.

Vendors for equipment under category (a) would be subject to prequalification.

3.12 In accordance with successful practices for procurement under ICB used in recent education and technology advancement projects in Korea, OSROK, with one exception, would not be required to refer equipment contracts to the Bank for prior review before making contract awards. However, complete bidding documents including commercial terms, schedules of requirements and technical specifications would be sent to the Bank before each invitation to bid. Bid evaluation reports, documents and contracts would be retained by OSROK for ex-post review by Bank missions. The exception applies to contracts for mainframe computers for the library network component. In this case, draft bidding documents including specifications and bid evaluation reports would be submitted for prior review by the Bank before inviting bids and awarding contracts respectively. This is necessary because of the complexity of the interface between library network software and hardware specifications and the sensitivity relating to ICB for major computer procurement. During negotiations, the Government agreed to submit to the Bank for prior review, the bidding-related documents mentioned above.

Disbursements

3.13 The proposed loan of US$50.0 million would be disbursed over a period of 5.5 years (Annex 5). This corresponds to the standard disbursement profile for education projects in Korea which is 5.5 years. The completion date of the project would be June 30, 1997 and the closing date December 31, 1997. Disbursements would be made on the basis of (a) 100% of foreign expenditures for imported equipment or, 100% of local expenditures (ex-factory cost) for locally manufactured equipment; and (b) 65% of local expenditures for other equipment items procured locally. Reimbursement for each equipment contract of US$300,000 equivalent or more, would be fully documented. Reimbursement for each contract of less than US$300,000, would be made against statements of expenditure for which full supporting documentation would be retained in MOE, for review as requested, by visiting Bank missions. Administrative and accounting capability in MOE is adequate to support the SOE procedure.

3.14 To facilitate disbursements, a special account, maintained in US dollars, would be set up at the Korea Exchange Bank in an amount of US$4.0 million, to cover the estimated average amount required to finance project expenditures for the next four months. Applications for replenishment of the

special account would be submitted to the Bank on a quarterly basis or whenever the amount requested exceeds 50% of the initial deposit, whichever comes first.

Accounts, Audits and Reporting

3.15 MOE would maintain project accounts in accordance with sound accounting practices. During negotiations, the Government gave assurances that audited accounts, including the special account and statements of expenditure (SOE) would be sent to the Bank within six months of the end of the financial year. Audit reports would include a separate opinion for expenditures under SOE procedures. The Government would submit semi-annual progress reports to the Bank in about March and September and provide status reports for visiting missions.

D. Environmental Impact

3.16 The project would not have any negative impact on the environment. The equipment to be supplied under the project would be located in properly designed facilities which operate under standard safety procedures. To the extent that the project assists in strengthening the teaching of science curricula, environmental education will also be strengthened. Following criticism of high school science curricula in the early 1980s as bearing little relevance to students' daily lives, subsequent curriculum revisions placed greater emphasis on environmental issues especially the negative aspects of science and techn logy development such as pollution. All the departments of natural sciences in the participating universities offer a range of courses in environment-related fields. These will benefit from the supply of equipment under the project.

E. Impact on Women

3.17 Women are overcoming their traditional reluctance to enroll in natural science programs as indicated in rising enrollment trends (para. 1.13). To the extent that the project would assist in improving the quality of science education in the high schools and universities, better-qualified women scientists would become available for entry to higher education and employment.

IV. BENEFITS AND RISKS

A. Benefits

4.1 The project would assist in strengthening science programs in the secondary schools and universities and this in turn would lead to higher quality graduates in science and engineering. The long-term result would be a stronger science and technology infrastructure which would underpin Korea's priority for high-technology industrialization. The project would also support the introduction of an innovation in the form of an automated library network which would improve information flows in the universities thereby

increasing the effectiveness of teaching and research. The technical feasibility of the network and the arrangements for its long-term implementation, have been strengthened through technical assistance provided by the Bank during project preparation.

B. Risks

4.2 The only risk associated with the project relates to the ability of local authorities to design and implement the libraries computerization component. This is an innovative activity which would require the utilization and coordination of relevant technical expertise drawn from a number of institutions. This would be achieved through the operation of an appropriate policy body (CULA) to handle broad design and implementation issues, supported by technical groups to handle detailed design activities.

V. AGREEMENTS REACHED AND RECOMMENDATION

5.1 The Government has agreed to the following:

(a) the development of practical science courses in the science education centers and procurement of related equipment, would be in accordance with guidelines acceptable to the Bank (para. 2.6);

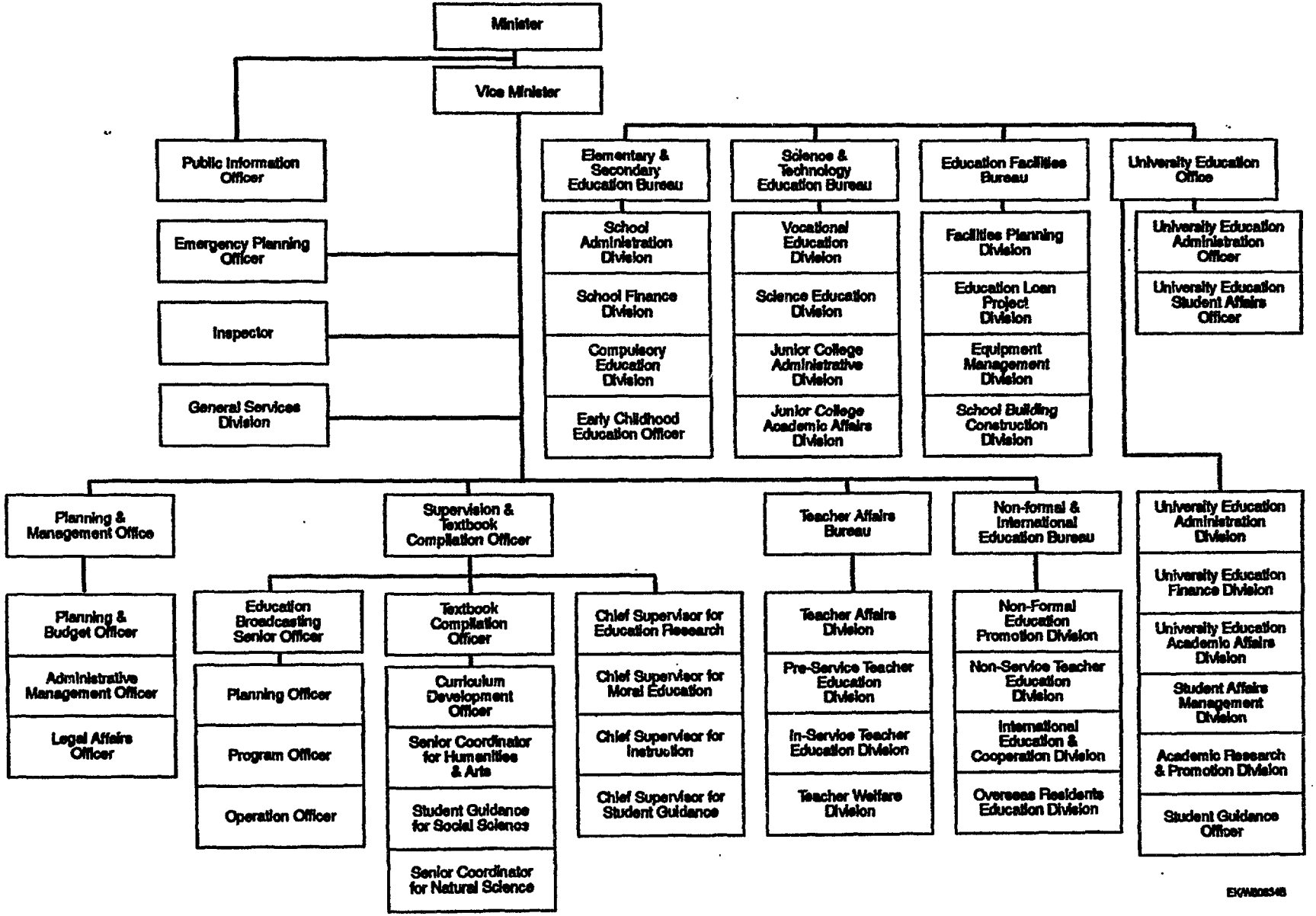
(b) the maximum unit price of equipment items would be US$50,000 for equipment procured in support of undergraduate science departments and US$100,000 for equipment items procured for the joint equipment centers and institutes of basic science, unless otherwise agreed with the Bank (para. 2.7);

(c) with respect to contracts for mainframe computers, draft bidding documents including specifications and bid evaluation reports would be submitted for prior review by the Bank before inviting bids and awarding contracts respectively (para. 3.12); and

(d) audit reports would be submitted by the Government to the Bank within six months of the end of each financial year (para. 3.14).

5.2 Subject to the above conditions, the project constitutes a suitable basis for a Bank loan of US$50 million equivalent to the Republic of Korea for a term of 15 years, including 5 years of grace at the Bank's standard variable interest rate.

KOREA
SCIENCE EDUCATION AND LIBRARIES COMPUTERIZATION PROJECT
Organization of the Ministry of Education



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ANNEX 1

KOREA

SCIENCE EDUCATION AND LIBRARIES COMPUTERIZATION PROJECT

Detailed Project Costs
(Won million)

	Equipment	Equipment Transportation and Installation	O & M	Consumable Materials	Training	Total Cost Won M	Total Cost US$ M
Science Education Centers	3,650	211	606	606	-	5,073	6.9
Undergraduate Science Education	18,250	1,095	2,986	2,986	-	25,317	34.7
Library Network	14,600	876	2,380	2,380	256	20,492	28.1
Baseline Cost	36,500	2,182	5,972	5,972	256	50,882	69.7
Contingencies							
Physical	1,825	109	299	299	13	2,545	3.5
Price Increase	4,152	315	860	860	38	6,225	8.5
Subtotal Contingencies	5,977	424	1,159	1,159	51	8,770	12.0
Total Project Cost							
Won million	42,477	2,606	7,131	7,131	307	59,652	
US$ million	58.1	3.6	9.8	9.8	0.4		81.7

ANNEX 2

KOREA

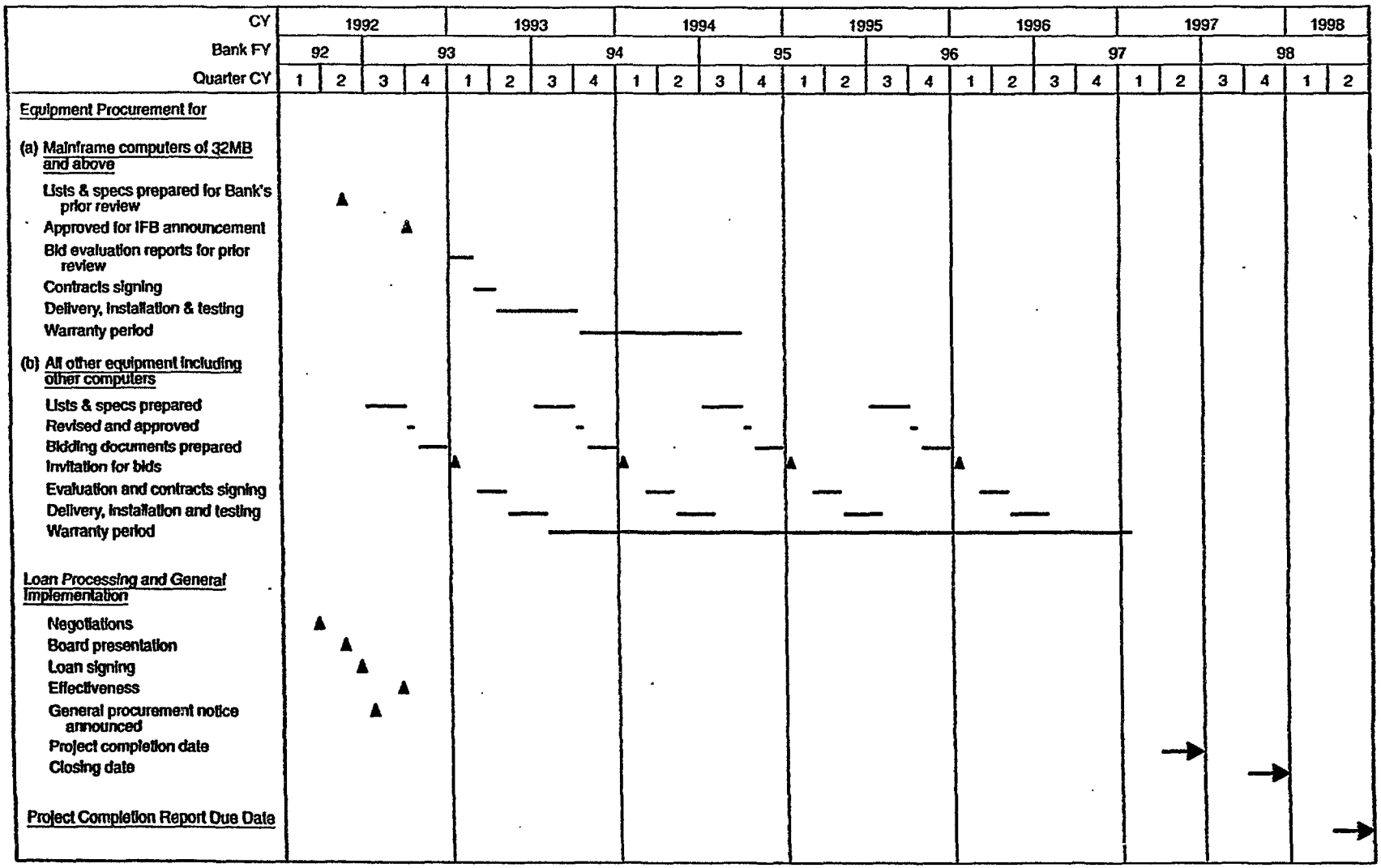
SCIENCE EDUCATION AND LIBRARIES COMPUTERIZATION PROJECT

Project Expenditure by Year and Recipient

	Base Costs (Won million)						Total Cost	
	92/3	93/4	94/5	95/6	96/7	97/8	Won M	US$M
Science Education Centers	409	1,219	1,920	1,007	409	109	5,073	6.9
Undergraduate Science Education	1,723	5,877	9,417	5,263	2,336	701	25,317	34.7
Library Network	1,044	3,110	8,140	6,110	1,548	540	20,492	28.1
Baseline Cost	3,176	10,206	19,477	12,380	4,293	1,350	50,882	69.7
Contingencies								
Physical	159	510	974	619	215	68	2,545	3.5
Price Increase	70	682	2,209	2,007	915	342	6,225	8.5
Total Project Cost	3,405	11,398	22,660	15,006	5,423	1,760	59,652	81.7
Foreign Exchange	2,522	8,446	16,830	11,113	3,980	1,272	44,164	60.5

ANNEX 3

KOREA
SCIENCE EDUCATION AND LIBRARIES COMPUTERIZATION PROJECT
Schedule of Implementation



ANNEX 4

ANNEX 5

KOREA

SCIENCE EDUCATION AND LIBRARIES COMPUTERIZATION PROJECT

Disbursements

IBRD Fiscal Year and Semester	Disbursements			Disbursements Profile /a (%)
	Semester	Cumulative	as % of Total	
	----------US$----------			
1993				
1	4.0 /b	4.0	8.0	1
2	0.0	4.0	8.0	3
1994				
1	4.0	8.0	16.0	5
2	6.0	14.0	28.0	10
1995				
1	9.0	23.0	46.0	23
2	9.0	32.0	64.0	44
1996				
1	8.0	40.0	80.0	70
2	5.0	45.0	90.0	81
1997				
1	2.0	47.0	94.0	92
2	2.0	49.0	96.0	97
1998				
1	1.0	50.0	100.0	100

/a Standard disbursement profile for education projects in Korea.

/b Initial deposit in Special Account.

ANNEX 6

KOREA

SCIENCE EDUCATION AND LIBRARIES COMPUTERIZATION PROJECT

Selected Documents Available in the Project File

A. Reports and Studies Related to the Sector/Subsector

A-1 Problems and Issues in Science Education in Korea, Han Jong-Ha, KEDI, September 1986.

A-2 The Cognitive Development of Secondary School Students in the Republic of Korea, Han Jong-Ha, KEDI, September 1986.

A-3 Education in Korea 1989-90, MOE.

A-4 Korea Higher Education - Its Development, Aspects and Prospects, KCUE, 1990.

B. Reports and Studies Related to the Project

B-1 Operation of the Student Science Centers, MOE, undated.

B-2 University Science Education Part, MOE, undated.

B-3 Computerization Project of Universities and Libraries, MOE (ELPD), February 25, 1991.

B-4 Automation Project of Seoul National University Library, SNU Library, March 6, 1991.

B-5 The Progressive Plan of Interim Evaluation Criteria for the Network Effects, MOE, November 12, 1991.

B-6 Materials Related with S/W System Development of SNU Library, MOE, November 12, 1991.

B-7 Recent Events of College and University Libraries Computerization, MOE, November 12, 1991.

B-8 Material for IBRD Mission on Secondary Science Education, MOE/ELP, November 18, 1991.

B-9 The Introduction Plan for Facilities of University Library Computer Network, CNCULD, November 25, 1991.

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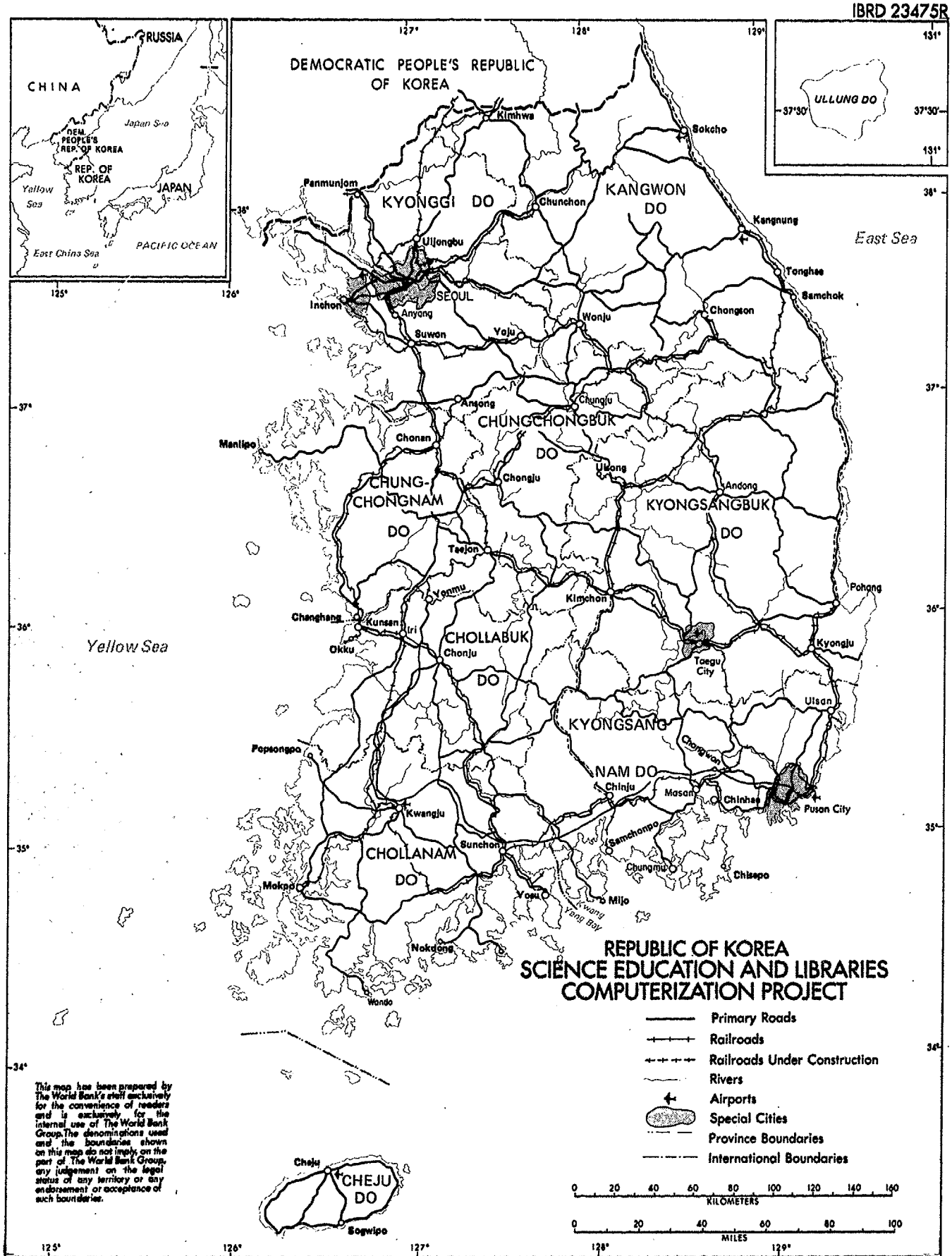

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APRIL 1992