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ABSTRACT

In 1987, the Bulgarian government and cooperating international agencies launched the program, "Children in the Information Age," a project aimed at: conducting and promoting national research into, exchange of information about, development and application of, practical training in, and methods and techniques for the introduction of informatics in the education of children; and assisting the international community to pursue similar endeavors by means of making its research facilities and training programs available to interested scientists and students from other, particularly developing, countries. Outputs of the project included: (1) establishment of the Research Centre for Educational Informatics (RCEI); (2) awareness of the introduction of computers and related tools into the process of education and education of teachers; (3) research, development, and adaptation of training systems; (4) implementation of new methods and new tools, including hardware, software, and videoware; (5) training activities; (6) a system of scientific and technical publications and information bulletins; and (7) exchange of experience. RCEI activities for the near future will include computer-based environments in math and science education, design and implementation of multi-functional technological hardware devices, design and implementation of artificial intelligence-based tools and systems, experimental and implementation activities, and training of specialists. (Contains 35 references.) (ALF)

Restricted
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Terminal Report

BULGARIA

Introduction of Informatics in Education of Children

Project Findings
and
Recommendations

Serial No. FMR/ED/RI/92/239(UNDP)

United Nations Educational,
Scientific and
Cultural Organization

United Nations
Development
Programme

Paris, 1992

BULGARIA

INTRODUCTION OF INFORMATICS
IN EDUCATION OF CHILDREN
(Research Centre for
Educational Informatics)

Project Findings and Recommendations

Report prepared for the Government of the Republic of Bulgaria by the United Nations Educational, Scientific and Cultural Organization (UNESCO) acting as Executing Agency for the United Nations Development Programme (UNDP)

United Nations Educational,
Scientific and Cultural
Organization

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Table of Contents

A. Objectives (intended and achieved)

At the beginning of the 1980's, due to the rapid application of locally produced microprocessors, a series of experiments started in pilot schools all over the country, and a network of computer clubs was established. Taking into account these developments and the significance of the integration of informatics and computer equipment into the world of the younger generation, the Bulgarian Government, with the assistance of international agencies launched the International Programme "Children in the Information Age". This large-scale undertaking has been and is actively supported by the international community of scientists and specialists in the field of computer applications in education.

In March 1987, a UNDP Project BUL/86/003 "Introduction of informatics in education of children", with UNESCO as Executing Agency, was started.

The Project aimed at achieving the following ultimate goals:

- To conduct and promote national research into, exchange of information about, development and application of, practical training in, methods and techniques for introducing informatics into the education of children.
- To assist the international community to pursue similar endeavours by means of making its research facilities and training programmes available to interested scientists and students from other, particularly developing, countries.

These objectives were successfully reached through the outputs listed below.

B. Outputs sought and produced

The following Project outputs were established as operational goals:

- Awareness of the introduction of computers and related tools into the process of education and education of teachers.
- Research, development and adaptation of training systems.
- Implementation of new methods and new tools - hardware, software, videoware, etc.
- Establishment of a system of scientific and technical publications and information bulletins.
- Exchange of experience in the above fields.

At the end of the Project, these outputs have given the following results:

- Establishment of the Research Centre for Educational Informatics (RCEI), which became a focal point for all national activities related to the application of advanced information technology to children's education.
- The development and organization of further research on the problems of children in the information age, particularly by means of comparing and analysing the social, cultural, economic, and psychological results of the application of computers at the earliest age.
- The co-ordination and stimulation of research, development, and adaptation activities in the field of educational hardware, software and related teacherware, and to promote their application in the education of children.

- The organization and facilitation of the national exchange of theoretical and applied findings concerning computer issues, as well as information concerning training courses, software products and systems; project designs and technical documentation concerning specialized equipment and systems for teaching, etc.
- The training and increasing of the qualifications of teachers and specialists in the efficient use of computers in education.
- The popularization of the positive aspects of computer learning and playing, as well as the new and interesting outcomes of research projects and practical experiments with a view to educating the public taste to the uses of computer technology for educational and amusement purposes, etc.
- The dissemination, at the national level, of the results of international co-operation in the field of new information technology, as well as the assistance to developing countries by placing the national resources at their disposal.

C. Findings and recommendations

During the Project period, the RCEI achieved considerable results in the development and implementation of environment of tools and systems for educational software design and development, the introduction of computer programmes and teaching materials into the educational process, the investigation, development and adaptation of training systems, in teachers and instructors' training and re-training. Thanks to its international activities the RCEI has established permanent close contacts with universities, associations, companies and experts from the USA, the UK, the ex-USSR, Greece, Canada, Thailand, Japan, etc. Members of the research teams participated actively with reports and scientific announcements in prestigious international scientific forums. Through UNESCO, a number of international missions of experts for exchange of experience in the research areas carried out by the RCEI were realized. All experts highly estimated the work done by the research teams.

The curriculum prepared for the new Bulgarian 12th-grade school, and its implementation in practice necessitates a search for new techniques of instruction, as well as new means for reducing the overload on students. Our search was particularly active in the sphere of new techniques of instruction, such as the application of school television, films, tape-recorders, programmed instruction with the use of computer technology. In the 1970's, all these experiments failed to produce any substantial results. The reasons for this are varied and generally known. We sought new factors which would make it possible to expand the educational process, to attract both teachers and students, and to encourage the creative process. At that moment, microcomputer technology emerged and began to be widely applied in secondary schools.

A number of conclusions have been drawn as a result of the Project and the follow-up programme's implementation. There are consequently many recommendations for the implementation of computer technology within the secondary education system, namely:

- The solution of the problems related to the material structure, to the supply of computers, and to the modification and development of computing equipment, peripheral devices, etc., produced in Bulgaria, is the first priority task.
- The possibility of using the experience and results of the practical implementation of computer technology in the higher educational institutions of the country, and the research potential of the higher institutions, the Academy of Sciences, as well as other institutions and organizations, is extremely important.

- The wide application of computer technology, particularly microcomputers and microprocessors in education, raises a number of questions related to its study and application as a technical aid for improving the quality of the educational process.
- Computer technology and its study are important for the formation of the students' world outlook, since they create conditions for new trends in thinking, revealing the role of computers in automation and control systems, in changes in the character of labour, and in problems of quality and productivity. The cultivation of algorithmic thinking is particularly important for the students' development.

D. Lessons learnt

One of the most important questions contemporary educational and training systems are faced with is how to intensify learning processes in the presence of computers and information technologies in all spheres of human activity. The Research Centre for Educational Informatics has played an important role in uniting the efforts of the various teams engaged in research and development activities since 1987. Its future efforts will be focussed on the following:

- To carry out and assist on a national scale fundamental and applied research, information exchange, development and application of methods and tools, specialists training for the introduction in education and training of new information technologies.
- To assist international organizations and institutions engaged in similar projects by popularizing and disseminating educational hardware, software and programmes for instruction among educational and training specialists and teachers from Eastern Europe and the developing countries.
- To organize and take part in the organization of international events (conferences, meetings, symposiums) dedicated to the problems relevant to the use of new information technologies in education.
- To organize and assist the international exchange of educational experts and training specialists by setting up and maintaining specialized databases and networks of inter-institutional contacts and connections, as well as to disseminate information about books and publications on advanced educational and training technologies.

Total Government Contribution: Leva 4,000,000 (in kind)

Total UNDP Contribution : US $215,000

UNDP/BUL/86/003 - Introduction of Informatics in Education of Children

(Research Centre for Educational Informatics)

TERMINAL REPORT

A. INTRODUCTION, DEVELOPMENT PROBLEMS AND IMMEDIATE PROBLEMS ATTACKED

1. At the beginning of the 1980's, due to the rapid application of locally produced microprocessors, a series of experiments started in pilot schools all over the country, and a network of computer clubs was established. Taking into account these developments and the significance of the integration of informatics and computer equipment into the world of the younger generation, the Bulgarian Government, with the assistance of international agencies like the United Nations Children's Fund (UNICEF), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Health Organization (WHO), the International Institute for Applied Systems Analysis (IIASA) and the International Federation for Information Processing (IFIP), launched the International Programme "Children in the Information Age". This large-scale undertaking has been and is actively supported by the international community of scientists and specialists in the field of computer applications in education.

2. The Programme aimed at achieving the following ultimate goals:
   - To conduct and promote national research into, exchange of information about, development and application of, practical training in, methods and techniques for introducing informatics into the education of children.
   - To assist the international community to pursue similar endeavours by means of making its research facilities and training programmes available to interested scientists and students from other, particularly developing, countries.

3. The Programme's outputs were:
   - Awareness of the introduction of computers and related tools into the process of education and education of teachers.
   - Research, development and adaptation of training systems.
   - Implementation of new methods and new tools - hardware, software, videoware, etc.
   - Establishment of a system of scientific and technical publications and information bulletins.
   - Exchange of experience in the above fields.

4. The Project Document, endorsed on 5 March 1987, for the execution of the UNDP project BUL/86/003 "Introduction of informatics in education of children", with UNESCO as Executing Agency, states as its immediate objectives and problems the following:

a. To establish a research centre for educational informatics, which is to become a focal point for all national activities related to the application of advanced information technology to children's education.
b. To encourage and develop further research on the problems of children in the information age, particularly by means of comparing and analysing the social, cultural, economic, and psychological results of the application of computers at the earliest age.
c. To co-ordinate and stimulate research, development, and adaptation activities in the field of educational hardware, software and related teacherware, and to promote their application in the education of children.
d. To organize and facilitate the national exchange of theoretical and applied findings concerning computer issues, as well as information concerning training courses, software products and systems; project designs; and technical documentation concerning specialized equipment and systems for teaching, etc.
e. The training, and increasing of the qualifications of teachers and specialists in the efficient use of computers in education.
f. To popularize positive aspects of computer learning and play, as well as new and interesting outcomes of research projects and practical experiments with a view to educating the public taste to the uses of computer technology for educational and amusement purposes, etc.
g. To permit the maximum dissemination, at the national level, of the results of international cooperation in the field of new information technology, as well as to render assistance to developing countries by placing the national resources at their disposal.

5. In the course of the Project Document development and its ratification by the respective international and national institutions and agencies, a definite logic has been adopted towards the solution of the above problems. This logic evolved from the problems' interrelation and the system's approach adopted as a methodological base for their solution. The system's approach predetermined the three main stages of the Project's execution. They were outlined in the Work Plan and defined the Project's design.

Stage 1

6. Institutionalization of the Research Centre for Educational Informatics (RCEI) and integration of the national resources (scientists, specialists and funds) in an overall programme. Structuring of research problems and outputs within the framework of the programme, and committing research teams and groups to the execution of these problems and outputs. The Work Plan, at this stage, also envisaged considerable preliminary research on the problems and outputs set in the programme.

Stage 2

7. Together with the research and development activities, the Work Plan, at this stage, included verification of the educational software developed, first in several pilot schools and later on, by the end of the stage, in all experimental schools of the Research Group on Education. The development and improvement of educational software coincided with the initialization of research on problems related to the development of educational interactive systems, appropriate to new information technology on a world-wide scale. The main objective of the second stage was the nation-wide dissemination of the experience of pilot schools.

Stage 3

8. Active international activities, involving exchange of experience and products, and implementation of the above-stated development objectives - dissemination of the Research Centre's experience and products in the developing countries. This last stage was logically preceded by the organization of a number of international conferences, symposiums and seminars which made possible and stimulated the establishment and further development of effective operational contacts between the national focal point, RCEI, and the international community of scientists and specialists.

9. Both, the Executing Agency and the national authorities, were aware of the Project's unique nature still at its outset, when the Project's ultimate goals, development problems and immediate objectives were being formulated. Now that the project is ending, the experience gained and the assistance rendered by scientists and experts from all over the world prove that the goals established at the beginning of the project were justified, both in structure and content. The main cause for the identity of problems and objectives' formulations, at the beginning and at the end of the Project, is the retained and increasing influence of new information technology and its trends on education.

B. OUTPUTS PRODUCED AND PROBLEMS ENCOUNTERED

10. A detailed description of the basic Project's outputs is given in Annex I of the last version of the Project Document. The results actually achieved under each output, as well as the influence of factors, both those internal to the project and those in its environment, are described in the logical order of the outputs' presentation in the Project Document.

Output: Establishment of Research Centre for Educational Informatics.

11. At the beginning of May 1987 the RCEI was set up, closely connected to the Committee for Science to the Council of Ministers of the Republic of Bulgaria and the Bulgarian Academy of Sciences. The directorial, professional and technical staff were appointed. Four people of the professional and directorial staff division were sent for training in the United States (USA), one was sent on a study tour in France, the Federal Republic of Germany (FRG), the Netherlands, and the United Kingdom (UK). The necessary equipment was ordered and delivered for providing the best professional and scientific conditions. Five external resource persons were invited to and visited Bulgaria as experts on the formulation of the RCEI concept and to advise on the running of the initial research and training programme units and activities.

12. For a comparatively short time, activities planned for the first six months of the Centre's operation were organized and implemented. The UNDP 1987 budget contribution funds were utilized for equipment purchase, subcontracting, external resource persons and RCEI staff training tours.

13. In 1987, the Second International Conference "Children in the Information Age" was organized with the participation of the RCEI within the framework of the International Programme "Children in the Information Age". The conference was attended by scientists and specialists from more than 20 countries. It contributed to the wide exchange of experience and

information on the role of informatics and computerization in the changing meaning of literacy, to the development of new creative possibilities for children through and based on computer work.

14. The Conference, as well as the participation of Bulgarian specialists and experts in other national and international events, supported by the RCEI and the Project, provided possibilities for considerable exchange of experience and information about introducing informatics in education. Moreover, it became possible to plan and organize new activities during the following stages of the Project. The scientific and individual contacts helped to list the scientists who would be appointed experts by the Project for its following stages.

15. The organizational structure of the RCEI was built already at its establishment. It includes:
- The Research Laboratory in Educational Informatics to RCEI
- The Educational Software Laboratory to the Faculty of Mathematics of St. Clement of Ohrida University, Sofia
- The Laboratory for Informatics in Education of the Research Group on Education to the Bulgarian Academy of Sciences and the Ministry of Education
- The Video-Computer Centre to the Technical University, Sofia
- The School Laboratory in 119 Secondary Schools, Sofia

Research and experiments are executed by the Programme Council which consists of prominent scientists and specialists.

16. The bulletins, issued annually by the RCEI, reflect in detail the Centre's activities throughout the period of the Project (1987-1991).

17. Notwithstanding the political, social and economic changes in Bulgaria during the life of the Project, and thanks to the support rendered by the Bulgarian Academy of Sciences (BAS) and its higher management, the RCEI has retained its status as a division of the Centre for Informatics and Computer Technology to the Presidium of the Bulgarian Academy of Sciences and executes successfully all tasks set in the Project's Work Plan for the 1, 2 and 3 stages. The Centre has strengthened and further developed its international contacts and influence. It has grown into a prestigious research team and coordinating organ which unites, informationally and personally, the efforts of East European specialists, thus becoming a bridge between the institutions of the former socialist countries and the leading universities and associations of the developed countries. Evidence of this can be found in the programmes and proceedings of the 2nd and 3rd international conferences "Children in the Information Age". The establishment of the RCEI has been not only fruitful and expedient, but extremely cost-effective for the solution of all development problems, stated in the beginning of this report.

Output: Awareness of the introduction of computers and related tools into the process of education and education of teachers

18. Within the framework of the Project, RCEI played the role of a basic consultative organization of the Bulgarian Ministry of Education in the process of decision-making related to the introduction of computers and new information technology in education and training. The

specialists, working at and for the Centre, took part in the development and updating of both the first and the second national programmes for the introduction of computers in education. These programmes are basic governmental documents regulating the national problems, outputs and executors in the process of improving the system of education and training.

19. The national and international conferences, symposiums and seminars, organized within the framework of the Project and with the assistance of its resources, have contributed towards the dissemination of the concrete research and development outputs, produced by the Project, as well as to the wide-scale demonstration of the advantages of computer-aided education and the analysis of the social, cultural, economic and psychological consequences of the introduction of computers in the world of children and students.

20. Annex C shows the active participation of scientists and specialists in national and international events. Annex E contains the titles of the publications on the research and development outputs, produced under the Project.

Output: Research, development and adaptation of training systems

21. The research and development activities, managed by RCEI, have been carried out by scientists and specialists working at universities and institutes of the Bulgarian Academy of Science. These scientists and specialists were organized in teams for the execution of the following R&D subprojects.

22. *Subproject "Principles, Approaches, Tools and Methods for Teaching Informatics in the Primary and Secondary School"*. The experience in the field of teaching informatics at school, and, in computer-aided learning reported by different countries, has been analysed and evaluated. The goals of teaching informatics at school have been defined. A first version of textbooks in informatics for the fifth and the sixth grade have been developed and tested. A second version of the textbooks has also been developed and tested and the results - analysed. A guidebook to the fifth grade textbook has been developed making use of the experience accumulated by teachers. A textbook in informatics and mathematics for the eighth grade has been developed to be used all over the country. Educational software and methods for using computers in the primary school for teaching mathematics and languages have been developed and tested. Two consecutive versions of an environment for educational software development have been designed and implemented on the basis of AI methods. Experimental versions of LISP, LOGO and PROLOG have been developed on the basis of the environment created. Three consecutive versions of the educational software system "Plane Geometry" (a sort of a mathematics computer laboratory) have also been developed. Other software products developed are: the Maze and the Graphics Data Types graphics packages; Educational Syntax Analyser; versions of LOGO translated and adapted in Bulgarian, Russian and Spanish, as well as educational software on their basis. The Educational Software Laboratory to the Faculty of Mathematics of St. Clement of Ohrida University in Sofia develops educational software using an approach based on AI methods and means. The basic goals are to create high quality and easily portable products.

23. *Subproject " Principles, Approaches and Methods for Development and Application of Videocomputer Systems in Education"*. The application of videocomputer systems in education involves two main approaches: videocomputer systems used directly in the process of education, and videocomputer systems for video and videocomputer programmes, films and other instructional materials development. These are new information technologies in education and their development required comprehensive study of the literature available on the problems involved, as well as preliminary investigations of the possibilities for introducing videocomputer systems in the Bulgarian educational system. Part of the preliminary outputs were reported in the papers of the Second International Conference "Children in the Information Age", Sofia, Bulgaria, May 1987. The subproject and the Educational Videocomputer Centre (EVC) organized the international Seminar and Exhibition VIDEOCOMP'87, held in Sandanski, Bulgaria, October 12-17, 1987. The seminar aimed at investigating the level and scope of achievement in this field. There were 200 applications of which 60 were from abroad. In 1990, RCEI and EVC organized the 2nd international conference VIDEOCOMP'90 which was accompanied by an exhibition of hardware, software and courseware, and educational films review and competition. The programme of the conference included more than 200 announcements and papers delivered at regular and poster sessions, as well as reports by invited speakers from the United States, the United Kingdom, the ex-USSR, etc. The Educational Videocomputer Centre, main executor of above subproject, invited lecturers and specialists from abroad to read lectures and hold seminars, to share their experience in the development of interactive videocomputer systems and products, and to render assistance in the design and use of videofilms with computer graphics and animation. The Centre was engaged in a wide variety of scientific research involving: consultations (connected with projecting, development and use of videocomputer systems and based applied technologies for them); design of videocomputer complexes (concrete development, production and implementation of videocomputer systems in definite areas); hardware and software development (applications of computer graphics and animation, visualization of scientific research, laser disc systems); development of methodological approaches (for creation and use of interactive programmes and videofilms with computer graphics and animation, pedagogical and methodological adaptation of videocomputer systems, authoring systems, etc.); production of videofilms and interactive videocomputer programmes to be used by lecturers and teachers. For lecturers and teachers who wanted to make videocomputer programmes by themselves, different authoring systems were available. By using transparent sheets, slides, videoframes, graphics and animation, every lecturer and teacher could easily make a videocomputer programme for his lecture. The EVC produced scientific, educational and advertising videofilms. The combination of the videomaterial with the computer synthesized graphics and animation is very useful and cost-effective.

24. *Subproject "Methods and Tools for Knowledge Representation and Processing in Education"*. This subproject aimed at developing a model that would reflect the individual learning process, with an emphasis on the testing and knowledge assimilation stages. The analysis of the learning process has made it possible to construct a general programme aiming at the automation of the educational process using techniques developed in knowledge-based systems. This approach makes knowledge formalization and processing possible in education: knowledge of the subject of study; knowledge of the teaching methods, knowledge of the pupils' personal characteristics. Work done under this subproject includes:

- Investigation of the existing educational systems making use of information technologies for knowledge processing and of expert systems supporting the educational process.

- Working out of a general diagram for the automation of the educational process including technology tools for knowledge processing. This diagram makes possible the formalization and processing of definite types of knowledge used in the process of education.
- Experimentation in schools of the educational software product "Trigonometry II" using knowledge processing technology and designed to support trigonometry teaching in the ninth grade of the secondary school.
- A new version, considerably simple for operation, of the software product "Trigonometry II" has been developed on the basis of investigations made.
- Investigation of the possibilities of designing network models by means of PROLOG and of developing an experimental version of the language for these purposes.

The basic concepts underlying "Trigonometry II" and its possibilities are published in the proceedings of the Fourth International Conference of the Prolog Education Group (PEG): Learning with Artificial Intelligence, held in Uppsala, Sweden, 16-18 June 1989. "Trigonometry II" was demonstrated at the working meeting of the International Federation for Information Processing (IFIP) WG 3.1 in May 1989 and to specialists from the College of Education, Georgia, USA. The programme system "Trigonometry II" was included in the system of free software exchange of IFIP WG 3.1.

25. *Subproject "Theoretical Basis and Practical Applications of Computer Educational Systems (including Educational Local Area Networks).* The main objectives of this subproject were to provide a unified theoretical basis for designing programme-compatible computer educational systems and to put forward practical realizations for such systems. The work under this subproject proceeded in accordance with the established working schedules. Results have been obtained in the following areas:

- A technological model of the teaching process has been developed, which makes it possible to determine where to use computers in teaching.
- A theoretical model and analysis of the learning process have been made, in particular of the roles of the teacher and the student, that are to underline the computer educational systems' architecture.
- Functional structure models have been made of some machine-independent computer educational systems' subsystems: ergonomic backup, operative educational planning, statistics, and state-of-art analysis of the learner.

26. Other problems included in the work plan were grouped into three main areas: analysis and building up of a centralized functional structure models of general purpose local network (GPLN); analysis and building up of generalized functional models of computer educational systems (CES) as regards their input and output; developing general theoretical concepts for the composition, structure and functioning of a unified environment linking CES and GPLN. The most essential results have been obtained from the first of these three areas and partially from the second one. The results obtained from the first one are as follows:

- A review of microcomputer local networks has been done, specifically of their technical and functional characteristics and their possible educational applications;
- A theoretical and comparative study of the methods of access to the GPLN;
- Hierarchical models of system programme software support of GPLN.
- An analytical review of service protocols of GPLN.

Within the second area the following topics have been investigated:

- Functional structure models of CES in the learning process;
- Demands to the programme-compatible CES and their input/output functions.

27. The main outputs produced during the life of the project in this direction are:
    - A technological model of the teaching and learning processes has been developed which made the design of a unified environment (system), aiding the automation of these processes, possible. The environment structure includes the following principle parts: knowledge base; a subsystem for knowledge base development and control; a subsystem information representation, including an original graphics subsystem; a subsystem for operative planning and control of the teaching and learning processes; a dialogue subsystem, including an original authoring language that is simple and easy to use.
    - Teacher and learner models have been developed and realized, respectively of the teaching and learning processes, which are incorporated in the subsystem for operative planning and control.
    - A new approach to computer-oriented technology of teaching and learning has been developed and adopted, which can be used independently or be incorporated in the subsystem for operative planning and control.
    - A joint investigation of the functional characteristics of the separate subsystems of the computer-supported educational system (CSES) has been made on the one hand, and of the functional parameters of general purpose local networks, on the other.
    - A programme system for modelling an arbitrary general purpose local network has been developed with a view to its application in education.
    - A unified environment for linking computer education systems and local networks on structural level has been developed and realized, the placing and functional purpose of 4 types of interfaces being precisely determined.
    - A high degree of mobility of computer educational systems has been achieved on the basis of the subject-independent structure and the programming language C.
    - The separate subsystems have been tested and implemented and a commercial version of the whole system has been completed.

The developed environment can be successfully used both in secondary schools and higher educational institutes for design and development of computer-based educational tools by teachers (lecturers) without computer qualification

28. *Subproject "Development of Computer Systems for Knowledge Control"*. The team executing this subproject has been working on computer-assisted testing for about 10 years. Fifteen years ago a main frame programme system for examination through objective tests was installed at a few Bulgarian high schools and it was successfully used for a long period of time. In 1986 a programme system for computerized testing in colleges was developed and installed on Pravetz-82 microcomputers (Apple II + compatible). Two subtasks were under research:

    - The existing microcomputer testing system (TEST) operated on individual micros. A text and a graphics base were supplied providing the examiners the possibilities to add, change, and delete multiple-choice test items at any moment. Generation of tests, meeting a number of requirements (subject, difficulty, size, etc.) was provided by the

system. Testing results were saved in files, and multiple reports were printed on the examiners' request. Despite encouraging results obtained in colleges, it was expected that far easier use of such a system would be possible if the individual micros were connected in a network. During the last year a project for a network testing has been in progress. A detailed comparative study 'individual vs. network' testing system was carried out. A draft project based on the Bulgarian U-LAN network was started and the first results were reported at the meeting in August 1987 in Sofia and in September 1987 in Romania.

- In developing computerized adaptive testing strategies the team made use of two approaches. The first one is based on simple adaptive strategies, and the second - on the more sophisticated of the item response theory. The first approach is to be used both in testing and in drills and practice. These strategies aim either at testing the student to reach a certain appropriately defined 'threshold number', or at establishing whether a poor result in a particular area was casual. Adaptive testing on the basis of the item response theory consists of a procedure which selects the test items taking into account how successful the answers have been. Each next item to be presented is calculated by means of a maximum likelihood equation. The results of the first stage of this subproject appeared in the "Computer-aided Testing for Children" paper submitted to the "Children in the Information Age" conference in May 1987 in Sofia.

Research under this subproject involved:

- Experimentation of the developed tools for computer-assisted test control;
- Improvement of existing computer test control programmes in new environments and by means of new tools;
- Development of concepts, algorithms and experimental programmes for adaptive computerized testing;
- Investigations and development of an appropriate learner model with a view to its improvement in the process of computer education and computer test control;
- Investigation of computerized education quality by means of automated tools developed and improved by the team.

The following results have been obtained under above areas:

- Experimentation and practical application of the TEST system on 8-bit computers. The team, including two Research Group on Education (RGE) teachers, generated a base of test items and conducted several tests during classes in informatics. As a result of these tests, the system of testing was improved towards a more adaptable use of the hardware and conclusions on the possibilities and the reactions of teachers and pupils in the new circumstances of test and computer control were drawn. The results were hopeful and were reported at national and international events.
- Development of test systems in microcomputer networks. A model for the development of a network knowledge control system was created which was intended for U-LAN computer network. The necessary measuring was done of the TEST-8 system and operation of computer networks with external memory floppy disc drives was experimented.
- Automated generation of test items. Following the experiments on the PROLOG realization of some algorithms for automated test generation, a concept, as well as experimental algorithms for another approach to this problem's solution, were worked

out. It is based on a semantic network in the object area and AI methods for multiple-choice tests generation.

- Creation of a TEST system version for 16-bit computers. A TEST-16 model was developed in which new ideas and algorithms for adaptive computer testing were involved. Separate system modules were developed for test items base generation and testing with or without adaptive strategy. In this version only text test items were used. The initial idea of including graphical and other editors in the system providing possibilities for generation of test items of various types was changed because of the cooperation with the British company SWAN. It was decided to develop the system as an additional module to the authoring system SESIL which was translated into Bulgarian. In this way it became possible to use SESIL editors and interface.
- Use of new tools for computer tests generation. With the assistance of the British specialist, John Ayerst, a concept for a test system of new type was worked out permitting the use of test items of varied form and involving video frames, video sequences and sound.
- The problem of the learner modelling is of paramount importance to each system aiming at education individualization. The solutions described in literature are not appropriate to our problem as they are concerned with prototype intelligent tutoring systems operating in specialized subject domains. Because of the fundamental difficulties in this area most research is being conducted in a simplified, artificial object area - games. Some of the solutions offered can however be generalized, if they are viewed from a definite perspective. That is why, the existing prototype systems were classified with reference to three dimensions and some basic techniques were outlined for application in different subject domains. The place of these techniques in the architecture of intelligent tutoring systems was determined and a method, modelling the learner's individual qualities, was suggested. At present the team is working on a prototype intelligent tutoring system based on above-described ideas. As a concrete subject domain the team has chosen primary level integration training which is taught at higher institutes. The expert in the subject domain is an extension of muMATH system for sign integration, and the environment is IBM/PC.
- The quality of training and of instructional computerized tools was investigated. The quality of software products for production of instructional programmes was also tested by making use of the methods and programme developed by team members as well. An effective tool for authoring systems' assessment was thus developed and tested and the methodology was improved.

Output: Implementation of New Methods and New Tools - Hardware, Software, Videoware, etc.

29. With a view to implementing the tasks under this output a number of subcontracts were concluded with leading European firms and institutions in the field of new information technology.

30. The first subcontract was concluded with VIDEO LOGIC, a leading English firm in the field of interactive video systems. As a result of this subcontract two systems - MIC System 2000 and MIC System 3000, were delivered for the needs of the Project and one specialist was trained on site for work with these systems. The two MIC systems provide an entirely new

dimension to personal computing and enhance personal computers performance to include broadcasting quality video pictures which can be overlaid with computer generated text and colour graphics. They have been designed for use with IBM personal computers and compatibles and any industrial videodisc player PAL or NTSC. The MIC systems controller card plugs into an expansion slot of an IBM-PC, XT, AT or compatible machine. This card allows the computer to control the videodisc player, to combine computer and video signals into a single picture and perform real-time editing of the video, audio and computer signals. The software provided allows computer programmes written for the IBM-PC to take full advantage of the capabilities of the MIC controller card. This unprecedented degree of flexibility at a low cost brings interactive video within reach of anyone with a practical application or interest in learning. The adaptation and implementation of the MIC systems was done by the laboratory to the RCEI and the Video-Computer Centre to the Technical University, Sofia.

31. The second subcontract was concluded between RCEI and DIDA*EL. The cooperation between DIDA*EL and RCEI was aimed at benefiting the research and development activities of both sides in the field of information technologies in education. The joint activities were focused on research and technology transfer. Research was mainly concerned with the application of artificial intelligence tools in education. The following aspects of this work were considered:

- The application of existing AI tools to facilitate the development of educational software. This includes the use of high level AI languages, integrated environments for knowledge representation, and Expert System shells.
- The development of programming tools for the implementation of educational software. Special attention is paid on the use of AI techniques.
- Experimentation to determine the applicability of AI methods in the process of designing educational software.
- The development of educational knowledge base systems in particular areas which are of interest to both partners.

32. According to the subcontract the technological transfer had to be realized on the basis of:

- The exchange of educational software products, both formally and under contract.
- The analysis and testing of educational software products by both parties in order to determine the relevant users of an application.
- The adaptation of available educational software, for example, when it is translated into another language. A special emphasis is placed on educational software used for teaching foreign languages.
- The training of experts in the field of educational software. This includes researchers from all parties in the working groups developing educational software and organizing workshops for the training of specialists.
- The commercial distribution of software products according to the relevant signed agreements.

33. The work on the above-mentioned topics was organized in the following forms:

- The exchange of researchers. The visiting researchers take part in the working groups of the host partner and have full access to the information and resources used.
- Seminars. Where possible, the working seminars are organized in connection with international scientific events held in both countries.

- The production and publication of reports or papers on the results achieved in the joint research work.

34. During 1990, various research and development activities in the field of information technologies in education were carried out by both partners. These covered the main directions determined by the accepted model of cooperation, i.e. research work and technology transfer. The main form of joint work at this stage was the visit of two experts of the Project to DIDA*EL. The goal of the visit was to achieve some major progress in the activities suggested in the General Agreement, including the tasks planned in the Product Distribution Agreement between DIDA*EL and RCEI, signed on 27 October 1989.

35. A member of the University of Sofia visited DIDA*EL for the period 5 November to 7 December 1990. A member of the Institute of Informatics, BAS, visited DIDA*EL for the period 16 November to 14 December 1990. During their visits they were involved in the following activities: familiarization with the research projects and major achievements of DIDA*EL, as well as with the developed programme packages and tools in the field of information technologies in education; presentation of the research and development activities in the field of information technologies in education carried out in BAS and the University of Sofia; adaptation for Bulgarian users of the product STEP-BY-STEP which tutors English as a foreign language; participation in the EACRO seminar "Eastern European Horizons"; determination of the direction and scope of future joint research and development projects.

36. The third subproject concluded was between RCEI and LEGO DACTA. This subproject aimed at developing curriculums, educational software, methodological materials and textbooks for introducing activities based on LEGO kits in the educational system of the Research Group on Education (RGE). All developments were conformable to RGE fundamental principles. A senior expert of LEGO Dacta, took an active part in the concluding activities of each stage (30 November 1989, 31 March 1990, 30 June 1990, 1 September 1990, 1 June 1991). His responsibilities involved the following: expert assessment of all constructive and technical problems relevant to the use of LEGO kits; evaluation of the original interpretation, subjected to RGE concept, of the didactic and methodological materials of LEGO Dacta.

37. The working team, engaged in this subproject, prepared the textbooks' versions, took part in their experimentation and specified the software needed for the models' control. The software realization was carried out by a group of high-qualified software engineers. All intermediate and final results obtained at each stage of the project were evaluated by an experts' council which also gave advice on the methodological, software and hardware aspects of the developments. In 1989, two specialists of the team attended a special training course at the firm. The same specialists were invited by the firm in 1990 to discuss the results of the joint project. In October 1990 the firm LEGO Dacta provided the project with free-of-charge laboratory equipment and paper for the textbooks' printing.

38. The outputs of this subproject include:
- An original sequence of LEGO models for the activities I DESIGN and I CONSTRUCT.
- Textbooks for the activities I DESIGN and I CONSTRUCT based on the method of "Model Machine-Construction".

- Educational software.
- Technical documentation and catalogues of the used software.
- An original interface prototype for LEGO models computer control.

39. The results obtained under this subproject were disseminated as follows:
    - During the 1990/1991 school year an experiment was conducted in several pilot schools. The RCEI provided under this subproject LEGO sets and interfaces for the needs of the planned experiments.
    - Laboratories were set up and experiments were conducted in two secondary schools in Sofia.
    - The results achieved under this subproject were reported at scientific conferences in the country and abroad: the Third Conference "Children in the Information Age" held in 1989, Colloquium Frieburg in Switzerland in 1990, the World Conference on Computers in Education in Australia in 1990.
    - Through UNESCO the results obtained under the subproject were placed at the disposal of other interested countries: specialists in informatics from the developing countries, the participants in UNESCO projects SYR/86/012 and EGY/88/035, specialists from the Institute of Education to the Slovakian Academy of Sciences.

Output: Training

Teacher training

40. The teacher training courses organized within the framework of the Project were held twice a year - during the winter and summer holidays. These courses took into account that the majority of the teachers have shown professional creativity in applying informatics to other school subjects, in organizing the work with an insufficient number of computers, in adapting the informatics textbooks to the teaching of younger pupils. The most experienced informatics teachers participated in 1989 in a two-part seminar: during the first one they discussed the development of software supporting the textbooks and during the second one the structure of informatics lessons from a methodological point of view was considered. Additional training courses were organized for RGE teachers in Bulgarian language and literature. These courses aimed at demonstrating some of the possibilities provided by computers in language teaching such as writing and editing compositions on the computer, experimenting with language objects in a LOGO-based microworld. A one-week seminar was organized with primary school teachers on the problems of computer applications in the first four grades.

41. Other activities organized by the RCEI and the RGE section "School Informatics" were the annual RGE conference at which teachers could share their experience and ideas. A bulletin "Informatics and Mathematics" began to appear. Its main objective was to spread teachers' ideas related to teaching informatics and mathematics and to make them feel like members of an informatics society.

Case Studies

42. Since the 1989/1990 school year, the Project team has carried out an experiment with the pupils of two seventh grade geometry classes at a Sofia school. The aim of this experiment was to study the process of teaching mathematics in a computer environment. Data has been collected as records of discussions in the classroom when introducing the basic geometric objects making

use of LOGO extension called Plane Geometry System. The role of the teacher in an environment of this kind is to stimulate pupils creativity and to motivate them to acquire further knowledge of the subject. This experiment proved that pupils, especially 8th and 9th grade pupils, are cultivating habits promoting the investigation of problems whose answers are as yet unknown and thus helping them to feel as real mathematicians.

Extra-Class Activities

43. The extra-class activities are more flexible forms of organization enabling each teacher to demonstrate his or her creativity. The RGE experience proves the usefulness of some of them: publishing a pupils' magazine, organizing competitions, etc.

44. Bulgarian language and literature classes have lacked real motivation for a very long time. Very often the themes considered at literature lessons do not correspond to the children's age and interests and it is only the teacher who reads the pupils' compositions. Some RGE teachers in Bulgarian literature and language together with teachers in informatics decided to start publishing a pupils' magazine by using computers. The idea was met by the pupils with great enthusiasm for they were given the opportunity to become real writers. The computer is used not only for text processing but for drawing computer graphics and even for printing music texts.

45. Another extra-class activity was the so called Children's Software House. Pupils create programmes which later on are applied in the elementary school. In this way research laboratories, combining the efforts of teachers and pupils, can be established at every school. A great number of pupils might become good specialists even in a school environment. When working with such pupils RGE teachers were faced with the problem of finding computers. In such cases the joint efforts of school and university staff were worthwhile. An extra-class activity devoted to some topics in the field of artificial intelligence was carried out on 16-bit computers. Pupils' teams worked on several projects based on IBM Logo. A very popular form of school-university cooperation was the organized Pupils' University. A group of 15-20 pupils of Sofia schools were taught by university and RGE lecturers. A number of methods of teaching and learning (free exploration, guided discovery, project-oriented organization, etc.), as well as educational software (Terrapin Logo, Bulgarian Logo, Logo Writer) were experimented.

46. Organizing annual LOGO Olympiads was another good tradition in the RGE schools. Each olympiad is preceded by a long period of training and local competitions. The regulations of the competitions include the writing of programmes for a period of 2-3 hours and programmes' testing (40-60 minutes). The "relay-race" competition can be organized as an extra-class activity. The regulations of such a competition include team work without computers for about two hours and work on the computer for 45 minutes. Every team has at its disposal three computers. The team members exchange their computers and complete the work of their team-mates. This is a great stimulus to programme writing in good style.

Output: A System of Scientific and Technical Publications and Information Bulletins

47. The main objective under this subproject was to set up a system for scientific and specialized information on new technologies in education which would enable the exchange of information between the Project teams and the international community of scientists and specialists working in the field of computer application in education. During the Second

International Conference "Children in the Information Age" (Sofia, May 1987) the RCEI organized a working meeting of editors and publishers of educational informatics periodicals from Argentina, Hungary, USA, USSR and Bulgaria. The list of actions, adopted at the meeting, laid down the groundwork of the Network of Educational Informatics Periodicals (NEIP). It was decided that the editors present would forward to the RCEI at least one free copy of each issue of their periodicals, that they would send summaries of articles, translated into English, which would be made available upon request and that they would also send the names and addresses of other editors and periodicals in their regions and countries willing to join the Network. On 5-6 May 1988 the members of the Organizing Committee of the second meeting of editors and publishers met in Varna in order to work out its provisional agenda. Circular letters, inviting editors and publishers to join the Network and to attend the meeting, were sent to more than 60 periodicals in 14 countries. As a result of this, 25 periodicals from Western Europe and America joined the Network and started forwarding their publications to the RCEI. The Second Meeting, held in May 1989, was attended by the editors of 19 journals from 12 countries. In 1990 the first number of NEIP News, the bulletin of the Network, was published. It included information about 14 NEIP member journals: AI & Society (UK), British Journal of Educational Technology (UK), Computer for You (Bulgaria), Computers in Education (Sweden), Educational and Training Technology International (UK), Informatics and Education (USSR), Informatics (Lithuania), Information Technology and Learning (UK), Interactive Learning International (UK), Interactive Update (UK), Journal of Computer Assisted Learning (UK), Journal of Computer-Based Instruction (USA), Journal of Research on Computing in Education (USA), T.H.E. Journal (USA). During the second half of 1990 and the beginning of 1991 the NEIP was joined by a number of journals: CAELL Journal (USA), Computers in New Zealand Schools (New Zealand), Journal of Artificial Intelligence in Education (USA), Journal of Computers in Mathematics and Science Teaching (USA), Journal of Computing in Childhood Education (USA), Machine-Mediated Learning (USA), Multimedia & Videodisc Monitor (USA), Journal of Educational Multimedia & Hypermedia (USA), Mathematics and Informatics (Bulgaria), Continuing Progress of Computerization in Japan (Japan), CICC News (Japan). The scope of the Network has expanded both geographically and topically and this fact alone is a proof of the importance and significance of the NEIP project. In spite of the various obstacles, the RCEI succeeded in providing funds for the publication of NEIP News second number which contains information about 23 journals. At present 32 journals are members of the Network and are sending to the RCEI copies of their issues.

Output: Exchange of experience

48. Within the framework of the International Programme "Children in the Information Age" and implementing the Project, the RCEI participated and actively assisted the scientists and specialists working under the Project to take part in national and international events. Information about this can be found in Annex C and paras. 18-20 of this report. Special attention is paid to the implementation of Stage 3 of the Project envisaging the dissemination of experience gained and products developed in the developing countries. The Project Management and RCEI, supported actively by the Executing Agency, directed their efforts to rendering assistance to and cooperation with the Ministries of Education of Syria and Egypt in the execution of the two UNDP/UNESCO projects SYR/86/012 and EGY/88/035.

49. Under the Project and through the RCEI the Ministry of Education of Syria was assisted in the execution of project SYR/86/012 by experts and specialists from the following institutions:

- Educational Computer Systems Laboratory, Faculty of Mathematics and Informatics, University of Sofia - two one-week courses in "Programming language Logo and its applications to educational methods" at the teacher training centres in Aleppo and Damascus, 24 Nov. - 30 Dec. 1990.
- Research Group on Education, Bulgarian Academy of Sciences and Ministry of Education - two one-week courses in "Programming language Logo and its applications to educational methods" at the teacher training centres in Homs and Lattakia, 24 Nov. - 30 Dec. 1990.
- Educational Computer Systems Laboratory, Faculty of Mathematics and Informatics, University of Sofia - training of secondary school teachers in the educational uses of computer technology at the teacher training centres in Damascus and Lattakia, 18 Apr. - 10 May 1991.
- Institute of Mathematics, Bulgarian Academy of Sciences - two one-week courses in "Educational Informatics" at the teacher training centres in Homs and Aleppo, 18 Apr. - 10 May 1991.
- Institute of Informatics, Bulgarian Academy of Sciences - two one-week courses in "Design of Educational Software" at the teacher training centres in Damascus and Lattakia, 30 Apr. - 19 May 1991.
- Software Engineering Department, Institute of Mathematics, Bulgarian Academy of Sciences - two one-week courses in "Design of Educational Software" at the teacher training centres in Homs and Aleppo, 30 Apr. - 19 May 1991.
- Institute of Mathematics, Bulgarian Academy of Sciences - two two-week courses in "Development of Educational Software" at the teacher training centres in Homs and Damascus, 9 May - 7 June 1991.
- Faculty of Mathematics and Informatics, University of Sofia - two two-week courses in "Development of Educational Software" at the teacher training centres in Damascus and Homs, 9 May - 7 June 1991.

More details about the assistance rendered under this project can be found in the official mission reports of the experts to UNESCO.

50. In March 1991, the Project Manager and RCEI Director, accomplished a two-week mission in Cairo under UNDP/UNESCO project EGY/88/035 with the following terms of reference:

- To work with officials of the Ministry of Education to develop plans for the use of computers in Egyptian secondary schools. To teach and demonstrate general methods of strategic and operational planning for educational innovations.
- In collaboration with the Director General and with those members of the Ministry of Education's General Department of Educational Computing who have been assigned responsibility for planning and for the programme evaluation, to help:
  - develop appropriate evaluative criteria related to the specific operational objectives of all aspects of the Ministry's "National Computer Education Programme" and the supporting UNDP/UNESCO assistance project;
  - develop detailed operational plans and work plans for each succeeding phase of the Ministry programme and the UNESCO project;
  - identify the resources and inputs required at each stage;
  - identify strategies to obtain the needed resources;

- review evaluation results and modify plans and resource requirements appropriately;
- prepare reports and submissions to UNESCO/UNDP and other sources of external aid;
- develop longer range strategic plans relating to: the development in Egypt of educational software and software tools for use in the schools; the transition from the teaching of informatics in the secondary school to the general use in schools of computers to assist instruction in other subjects and to the administrative use of computers in schools;
- in all of the above, to work closely with the Director General and the officials with designated responsibility in planning to ensure that they become familiar with the operational and strategic planning methods which have been used and can apply them independently.

51. From 4 to 18 December 1991, the Project Manager was on a two-week mission with the concrete tasks to:

- develop detailed operational plans and work plans for each succeeding phase of the Ministry's National Computer Educational programme and the UNESCO project;
- identify the resources and inputs required at each stage, as well as strategies in order to obtain the needed resources;
- review evaluative results and modify plans and resource requirements appropriately;
- assist the national authorities in the preparation of 1992 work plan.

52. From 8 May to 21 June 1991, the leading expert in informatics and education and Project team leader, was on a UNESCO mission at the Ministry of Education of Egypt which involved the following tasks:

- to develop a training programme for future instructors who will, in turn, train secondary school teachers to teach introductory courses in informatics, special attention being placed on the demonstration and development of appropriate pedagogies;
- to define a plan for the implementation of the above programme;
- to conduct a series of courses destined for teacher trainers;
- to evaluate the course.

The courses conducted by Dr. Rumen Nikolov were on the following topics: new teaching methods, principles of structured programming, use of equipment, information and data handling, using application software, the forty-hour syllabus, some general computing concepts for teachers.

53. The Syrian and Egyptian project managements, as well as the managements of the Ministries of Education of both countries, highly estimated the assistance rendered by the experts and specialists working under Project BUL/86/003 and this had been repeatedly brought to the knowledge of the Executing . gency and the management of the Bulgarian project. The 3rd stage of the reported project has been not only effectively completed but through multiplying the input resources a high cost-effectiveness has been reached with respect to the problems attacked within the framework of international cooperation in the field of informatics in education.

54. RCEI and project specialists took part in a number of events at which they passed on their experience to experts and specialists from the developing countries. From 25 to 30 May 1989, within the framework of the UNESCO Intergovernmental Informatics Programme, in Varna, Bulgaria, a training course was held in informatics in education for educational specialists from such countries. The scientific programme of the course was worked out by the RCEI. The training course was attended by educational specialists from Algeria, Vietnam, Egypt, Kuwait, Lebanon, Nigeria and Sri Lanka. The lectures were read by specially invited lecturers from six countries: the UK - 1, Australia - 1, Bulgaria - 6, Zimbabwe - 1, USA - 3, Sweden - 2. During the training course they delivered 16 lectures, 2 computer demonstrations were organized. Three basic issues were tackled during the course:

- national strategies and organization of computer application in education;
- use of LOGO in education;
- new information technologies in education, tutoring environments, intelligent tutoring systems.

55. The general evaluation of above outputs shows that the project was successfully executed and the decisions of the mid-term programme review and the project tripartite review, held from 4 May to 6 May 1989 in Sofia, testify to this. Notwithstanding the small project budget (initially $200 000 and after the mid-term review increased to $215 000) all funds were correctly spent. 50% of the budget was used for purchase of equipment for the needs of the above-mentioned experimental centres and development laboratories, about 25% were spent on subcontracting and fee-contracting of external resource persons and the remaining 25% - on project specialists' training. The multiplication effect thus obtained, mainly through the dissemination of the produced outputs on a national and international level, give grounds to conclude that the UNDP and the national contributions had tended to the long-term effectiveness of the invested resources.

C. OBJECTIVES ACHIEVED OR LIKELY TO BE ACHIEVED IN THE NEAR FUTURE

56. The immediate and development objectives stated in point A, as well as the ensuing problems attacked during the three stages of the Project, have been achieved to a great extent. In spite of the social and economic changes in the country, the relative stability of the existing structures (the Bulgarian Academy of Sciences and the Ministry of Education) involved in the execution of the project will ensure the implementation of the Project Follow-up Programme.

57. The R&D activities under the Project Follow-up Programme will ensure the improvement of the achieved results in the direction of new technological tools utilization in the development and application of scientifically substantiated, psychologically and pedagogically consistent and user-oriented technologies in education and training. That is why, it will be expedient to set apart the main areas of RCEI activities:

Computer-based environments in Maths and Science education

58. The aim is to carry out fundamental and applied research in the field of new information technologies use in Maths and Science education. The integration of mathematics and informatics, as well as of science and informatics, is most strongly manifested in the development of programming environments of the Computer Lab type. Such computer labs are

already being developed in this country (e.g. Plane Geometry System, LEGO Lab). The main tasks will be: to develop an algorithmic approach to mathematics and science teaching; to elaborate instructional methods and techniques to be applied in the computer labs that are being developed; to develop and extend new software environments for instruction; to write computer lab-oriented teaching materials (textbooks, teachers' guides, etc.); to conduct experiments with the developed teaching materials and software with a view to their implementation into practice. The tasks in this area are closely connected with: the development of teacher and student computer-oriented models and the creation of respective tools for work with the models; the improvement of the user's interface; the extension of graphical subsystems possibilities of image animation; the development of databases into knowledge bases and of the respective tools for their control and use; the incorporation of expert systems for educational technology selection and management depending on the individual abilities of teachers and students; the development of tools for evaluation and documentation of the educational process.

Design and implementation of new multi-functional technological hardware devices

59. Work in this area involves: improvement of the technical and programming base towards development and implementation of video computer systems in education and training; development and application of interactive products; development of tools and systems for speech communication and elaboration of methods for their use in education; creation and application of heterogeneous networks of tools for information representation and processing for the purposes of the educational technologies; setting up of encyclopaedic information bank for the needs of the different school disciplines integrated in the educational process.

Design and implementation of AI-based tools and systems

60. Work in the area is connected with: research into the fundamental issues related to the architecture and realization of intelligent tutoring systems and intelligent educational environments, as well as investigation of the practical compromises which have to be made with a view to making possible their application in concrete educational practice; design of models reflecting the process of individual education focusing attention on the level of control and knowledge assimilation; investigation of knowledge types for automation of individual training; elaboration of a language on the basis of distributed processing of information for knowledge representation; selection of tools permitting the formation of a student's model including wrong concepts about the subject.

Experimental and implementation activities

61. A considerable part of the Project Follow-up Programme activities will be devoted to testing and applying the achieved results through educational experiments and experimental programmes for implementation in the educational practice. They will be conducted by the research teams of the specialized laboratories of the Bulgarian Academy of Sciences and the universities, as well as in the specialized classes and schools within the system of the Ministry of Education and the specialized schools for staff training and re-training. With the development of the Project Follow-up Programme, the scope of experimental and implementation activities will be enlarged: the results achieved will be implemented not only in isolated centres and schools, but in groups of experimental schools pursuing different objectives in the different regions of the country and on all levels of secondary and vocational education; anticipatory implementation in universities and development of patterns for new information technologies application in higher

education; setting up of an operative information network for analysis and evaluation of the implemented developments and results; organization of task-force meetings with research teams for mutual enrichment and integration of the scientific and applied results. Since 1991 the RCEI is the national coordinator of IEA (International Association for the Evaluation of Educational Achievement) projects TIMSS and COMPED.

Training and qualification of specialists from the country and from abroad

62. The Project Follow-up Programme envisages considerable extension of activities related to the training, qualification and re-qualification of educators, teachers and instructors. For the purpose, the experience gained so far and the established contacts of the R&D teams with different educational institutions' training centres and educators in practice will be used. Special attention in the realization of this objective will be paid to the possibilities of joint work with related projects in countries in Asia and Africa, like Egypt, Syria, Israel, Thailand, etc. There exists a real possibility to establish in Bulgaria under the developed Project an International Training Centre (its main objective will be instruction of educators and teachers from the former Eastern Block and the developing countries in new information technologies) with the assistance of specialists, already engaged in the implementation of the Project, from USA, Japan and Europe (The Association for the Development of Computer-Based Instructional Systems, The International Society for Technology in Education, the Education Development Centre, The Council of National Universities Centres for Educational Technology - Japan, The National Institute for Educational Research - Tokyo, The Centre for Educational research and Training - Kyoto, The European Learning Technology Association, etc.).

63. Besides the international financing (resources from the TEMPUS Programme, the DELTA Programme, etc.), the national contributions for the developed Project will be provided by the Bulgarian Academy of Sciences and the Ministry of Education. The Project will be sponsored by interested national associations, foundations and industrial chambers. Funds for the Project will also be provided by interested firms and cooperations. These funds will be spent on research and development activities, organization of seminars, symposiums and workshops, study grants/tours and contracts with external experts, financing of joint projects and subcontracts, purchase of hardware and software needed for the realization of the above-mentioned activities. As a basis, Project Follow-up Programme organization is foreseen under the Research Centre for Educational Informatics to the Bulgarian Academy of Sciences.

D. FINDINGS AND LESSONS LEARNED

64. During the Project period the RCEI achieved considerable results in the development and implementation of environment of tools and systems for educational software design and development, the introduction of computer programmes and teaching materials into the educational process, the investigation, development and adaptation of training systems, in teachers and instructors' training and re-training. Thanks to its international activities the RCEI has established close contacts with universities, associations, companies and experts from the USA, the UK, the ex-USSR, Greece, Canada, Thailand, Japan, etc. Members of the research teams participated actively with reports and scientific announcements in prestigious international scientific forums. Through UNESCO, a number of international missions of experts for

exchange of experience in the research areas carried out by the RCEI were realized. All experts highly estimated the work done by the research teams.

65. The curriculum prepared for the new Bulgarian 12th-grade school, and its implementation in practice necessitates a search for new techniques of instruction, as well as new means for reducing the overload on students. The Project Management's search was particularly active in the sphere of new techniques of instruction, such as the application of school television, films, tape-recorders, programmed instruction with the use of computer technology. In the 1970's, all these experiments failed to produce any substantial results. The reasons for this are varied and generally known. New factors were sought which would make it possible to expand the educational process, to attract both teachers and students, and to encourage the creative process. At that moment, microcomputer technology emerged and began to be widely applied in secondary schools.

66. The experience of the ex-USSR, the UK, France, Japan and the USA in introducing this technology, was analysed, and the need to start using microcomputers in Bulgarian schools as well, became obvious. In view of the importance and ever-increasing role of the computer in Bulgarian society, the Ministry of Education adopted a number of goal-oriented measures related to the computerization of secondary education, to pre-vocational education and to the acquisition of knowledge, skills and other requirements needed to work with computer equipment. In 1987 the Minister of Education announced that 6000 domestically produced microcomputers would be installed in secondary schools before the end of the year, and that by 1990 about 40,000 microcomputers of the Pravetz type would be in use in secondary schools.

67. During the three years following the adoption of the National Programme with the support of the RCEI and the Project, many results have been achieved:

- More than 16,000 micros have been delivered to schools;
- A 120-hour course in informatics was made compulsory in all secondary schools (10th and 11th grade in the 1986/87 school year;
- Two versions of initial textbooks in informatics in two parts (for the 10th and for the 11th grade) have been written and published;
- Teachers' handbooks, as supplements to the first and second parts of the informatics textbooks, have been written and published;
- A large number of study aids and other materials have been published;
- Considerable success has been achieved in the training and retraining of teachers (there are about 1,000 schools in the country). About 17,000 teachers have completed a one-week (36-hour) computer literacy course; 2,300 have finished a one-month course; 650, a three-month course, and 350, a one-year course;
- A teachers' training Chair for Informatics was established in the Department of Mathematics and Informatics at Sofia University in 1986. Similar chairs have been established in teachers' training colleges throughout the country;
- Research units in the area of education have been organized in some of the higher educational schools.

The Ministry has been allocated some 12 million leva annually towards the development and transfer of new techniques in secondary education (which is about 1 per cent of the total yearly expenditure for the national educational system, including pre-school education and construction projects).

68. Following the results of the Project and the Follow-up Programme's implementation, a number of conclusions have been drawn. There are consequently many ***prerequisites*** for the implementation of computer technology within the secondary education system, namely:

- The solution of the problems related to the material structure, to the supply of computers, and to the modification and development of computing equipment, peripheral devices, etc., produced in Bulgaria;
- The possibility of using the experience and results of the practical implementation of computer technology in the higher educational institutions of the country, and the research potential of the higher institutions, the Academy of Sciences, as well as other institutions and organizations.

Both these are prerequisites for the stable functions, self-renovation and constant improvement of the education system. The procedure for introducing computers into the secondary education system, the relevant stages, objectives and tasks, were part of a complex programme for the implementation of computer technology in secondary schools, worked out and approved by the Higher Council for Education at the Ministry of Education in Bulgaria.

69. The following ***facts*** were given particular consideration when the Follow-up Programme was being worked out, namely:

- The wide application of computer technology, particularly microcomputers and microprocessors in education, raises a number of questions related to its study and application as a technical aid for improving the quality of the educational process.
- Computer technology and its study are important for the formation of the students' world outlook, since they create conditions for new trends in thinking, revealing the role of computers in automation and control systems, in changes in the character of labour, and in problems of quality and productivity. The cultivation of algorithmic thinking is particularly important for the students' development.

70. In view of this, the main ***trends*** in the implementation of computer technology in Bulgarian secondary schools may be determined as follows:

- Training in the field of computer technology and the basic principles of programming, as an element of general education;
- Application of computer technology (microcomputers and microprocessors) as technical school aids;
- Application of microprocessor and microcomputer equipment as a means of control in such subjects, as automation of production, introduction to cybernetics, automation and computer technology, etc.

71. The Follow-up Programme has been elaborated with a view to complying with a number of basic ***needs***, namely:

- The introduction of qualitatively new control systems for different objects and processes and systems of an organizational type raises the problems of training specialists, their pre-vocational education, and the acquisition of knowledge, skills and needs.
- The control of complex technical devices, equipment and apparatus requires the acquisition of new skills and habits, development of the intellect - combinatory and intellectual thinking - a description of the various objects and systems, and the setting up and use of information facilities.

- The application of computers makes it possible to intensify and individualize the educational process, the means of individual control and the change in teaching strategy.
- The introduction of computers in education, particularly in secondary schools, is aimed at creating and pursuing a scientifically substantiated strategy for their implementation, in addition to encouraging research into the educational, psychological, physiological and other problems of computerization.

72. The main ***objectives*** of the Follow-up Programme are as follows:
- To provide for both theoretical and practical study of computer technology with the aim of training secondary school graduates in the programming, operation, maintenance and production of computer equipment, i.e. to provide for the particular profession;
- To provide extensive computer education with the aim of imparting a system of knowledge and skills in using computers, i.e. to promote computer literacy;
- To guarantee the effective use of computers as teaching aids, and to create the necessary software for general education;
- To provide the necessary technical facilities and personnel for the introduction of computer technology into secondary schools - training of teachers;
- To provide the necessary hardware and software for the control of the educational process and of the educational institutions.

E. RECOMMENDATIONS

73. One of the most important questions contemporary educational and training systems are faced with is how to intensify learning processes in the presence of computers and information technologies in all spheres of human activity. The Research Centre for Educational Informatics has played an important role in uniting the efforts of the various teams engaged in research and development activities since 1987. Its future efforts will be focused on the following:
- to carry out and assist on a national scale fundamental and applied research, information exchange, development and application of methods and tools, specialists training for the introduction of in education and training of new information technologies;
- to assist international organizations and institutions engaged in similar projects by popularizing and disseminating educational hardware, software and programmes for instruction among educational and training specialists and teachers from Eastern Europe and the developing countries;
- to organize and take part in the organization of international events (conferences, meetings, symposiums) dedicated to the problems relevant to the use of new information technologies in education;
- to organize and assist the international exchange of educational experts and training specialists by setting up and maintaining specialized databases and networks of inter-institutional contacts and connections, as well as to disseminate information about books and publications on advanced educational and training technologies.

All above activities will be implemented within the framework of the Project Follow-up Programme activities described in paras. 57-60 of the present terminal report.

ANNEX A

a) UNESCO Fee Contracts

Consultant	Origin	Specialization	From	To
Uri Leron	Israel	Teaching informatics and mathematics in high school	31 Oct - 8 Nov 1987	
Harry Pinxteren	Netherlands	Introduction of informatics in education of children	28 Nov - 5 Dec 1987	
Peter G.M. van der Heijden	Netherlands	The impact of informatization of society on children	28 Nov - 5 Dec 1987	
Birgitta Lindahl	Sweden	Socio-cultural impacts of computerization on society	13 - 20 Dec 1987	
Franklin Roberts	U.S.A	Computer-based education projects	13 - 21 Dec 1987	
Rhys Gwyn	U.K.	Use of computers in education	16 - 21 Jan 1989	
Erling Schmidt	Denmark	Teaching informatics in the primary and secondary school	20 - 24 Feb 1989	
Benedict du Boulay	U.K.	Intelligent Tutoring Systems	16 - 26 Aug 1989	
Joel Hillel	Canada	Teaching mathematics by using LOGO	13 - 22 Sep 1989	
Paul Goldenberg	U.S.A.	Teaching informatics in the primary and secondary school	8 - 17 Nov 1989	

Brian Silverman	Canada	Educational software development	2 - 10 Dec 1989
Cate Savage	U.K.	Video-Computer Systems in education	3 - 10 Mar 1990
Alan Anov	Denmark	LEGO-LOGO sub-project	March 1990 June 1990 September 1990
Peter Ross	U.K.	Programming languages and ITS	8 - 15 Dec 1990
Jonathan Briggs	U.K.	AI in education	14 - 20 Jan 1991

b) External Non-Project Resource Persons (Experts and Consultants)

Name of Expert/ Consultant	Country of Origin	Field of Specialization	Year of Visit
Seymour Papert	USA	Technocentrism in thinking about the school of the future	1987
Dines Bjorner	Denmark	Conceptual threads of datalogy, informatics and information technology	1987
Andrey P. Ershov	USSR	School informatics in the USSR	1987
Shoji Shiba	Japan	School or home computer literacy and influence on children	1987
David Tinsley	UK	Informatics in and out of school	1987
Ronald Lauterbach	FRG	New meanings of literacy	1987
Sylvia Charp	USA	Computer use in education: trends, challenges and opportunities	1987
Tom van Weert	Netherlands	Literacy in the information age	1987
Nick Rushby	UK	The information age in focus	1987
Judith Hammond	Australia	Information technology and literacy in education	1987
A.K. Ajlamazyan	USSR	Summer school "Young Programmer"	1987
John Ayerst	UK	Knowledge based systems in education (Using interactive video as a tool for learning)	1987
Stefano Cerri	Italy	AI as foundation for the design of an information society	1987
Hakudo Kobayashi	Japan	Transition from "teaching by video" to "self-learning by video"	1987
Kurt Kreith	USA	Problem solving and the search for a new meaning of literacy	1987
Gianna Martinengo	Italy	Authoring systems for language teaching	1987

V.V. Rubtsov	USSR	Psychological aspects of computer based instruction	1987
Betty Collis	Netherlands	Impact of IT in education on children's cognitive development	1989
J. Olveira	USA	Models for computer-related educational policy	1989
S. Robinson	USA	Technologies for group-based instruction	1989
Dennis Harper	US Virgin Islands	Computers in education - a developing world perspective	1989
Tom Reeves	USA	Computer-based instruction	1989
Robert Cavalier	USA	Multi-media technologies in education	1990
Edward Friedman	USA	Machine-mediated learning	1991

ANNEX B

Counterpart Staff

Name	Position held	Qualification
Board of Directors		
Ivan Stanchev	Director, assoc.prof.	Mathematician
Ljubomir Davidov	Deputy Director, assoc.prof.	Mathematician
Dentcho Batanov	Deputy Director, assoc.prof.	Engineer
Regular RCEI staff		
Yanka Petrovska	Editor	Philologist
Pravda Stancheva	Project Coordinator	Philologist
Elena Vacheva	Software and Technical Coordinator	Mathematician
Krestjo Krestev	Desktop Publishing	Academy of Arts
Subproject Team Leaders		
Bojidar Sendov		Mathematician
Rumen Nikolov		Mathematician
Avram Eskenazi		Mathematician
Gospodin Jelev		Engineer
Hristo Dichev		Mathematician

ANNEX C

List of fellowships

Name of Fellow	Country of Origin	Field of Study	Place of Study	Period of Study From	To
Boyan Penkov*	Bulgaria	Establishment of contacts with international institutes and universities	France		
			IREM of Grenoble	18 - 22 Oct '87	
			Inst. National de Recherche Pedagogique	23 - 29 Oct '87	
			United Kingdom		
			Univ. of London, Inst. of Education	30 Oct -3 Nov '87	
			King's College	3 - 8 Nov '87	
			Netherlands		
			National Institute for Curriculum Development, Enschede	9 - 11 Nov '87	
			National Institute for Educ. Measurement, Arnheim	11 - 13 Nov '87	
			Germany		
			Institut fur Didaktik der Mathematik, Bielefeld	13 - 17 Nov '87	
Dentcho Batanov	Bulgaria	Computer-based technologies in education; computer-aided learning and teaching	USA	16 Apr '88 -	
			Univ. of California at Irvine		
			Univ. of California at San Diego		
			Carnegie Mellon Univ.		
Michail Draganov	Bulgaria	Computer-based technologies in education; computer-aided learning and teaching	USA	16 Apr '88 -	
			Univ. of California at Irvine		
			Univ. of California at San Diego		
			Carnegie Mellon Univ.		

Rossen Filimonov	Bulgaria	Teaching informatics by using LOGO; educational software development	USA Carnegie Mellon Univ. MIT	14 - 23 Feb '88
Bojidar Sendov	Bulgaria	Teaching informatics by using LOGO; educational software development	USA Carnegie Mellon Univ. MIT	14 - 23 Feb '88
Ivan Stanchev*	Bulgaria	Computers in education	Switzerland ECCE'88, Lausanne	25 - 29 Jul '88
Dencho Batanov*	Bulgaria	Computers in education	Switzerland ECCE'88, Lausanne	25 - 29 Jul '88
Rumen Nikolov*	Bulgaria	Computers in education	Switzerland ECCE'88, Lausanne	25 - 29 Jul '88
Evgenia Sendova*	Bulgaria	Computers in education	Switzerland ECCE'88, Lausanne	25 - 29 Jul '88
Rumen Radev*	Bulgaria	Computers in education	Switzerland ECCE'88, Lausanne	25 - 29 Jul '88
Bojidar Sendov*	Bulgaria	Computers in education	Switzerland ECCE'88, Lausanne	25 - 29 Jul '88
Genadi Agre	Bulgaria	Educational informatics; artificial intelligence	Germany ECAI'88, Munich	31 Jul - 6 Aug '88
Gospodin Jelev	Bulgaria	Video-computer systems; interactive video in education	Netherlands INTERACTIVITY'88	4 - 8 Oct '88
Ognian Gavrailov*	Bulgaria	Application of LEGO sets in education	Denmark LEGO Dacta, Billund	17 -24 Dec '88
Velichko Dobrinov*	Bulgaria	Application of LEGO sets in education	Denmark LEGO Dacta, Billund	17 - 24 Dec '88

Ognian Gavrailov*	Bulgaria	Computer applications in education	United Kingdom ECONOMATICS, Sheffield	5 - 11 Mar '89
Velichko Dobrinov*	Bulgaria	Computer applications in education	United Kingdom ECONOMATICS, Sheffield	5 - 11 Mar '89
Darina Dicheva	Bulgaria	Learning with artificial intelligence	Sweden PEG Conference Uppsala University	15 - 19 Jun '89
Ivan Stanchev	Bulgaria	Educational software at secondary level	Iceland IFIP WG 3.1 Conference, Reikjavik	17 - 23 Jun '89
Bojidar Sendov	Bulgaria	Educational software at secondary level	Iceland IFIP WG 3.1 Conference Reikjavik	17 - 23 Jun '89
Gospodin Jelev	Bulgaria	Video-computer systems in education	United Kingdom Audio-Visual Centre, Univ. of London World Conference & Exhibition of IFTDO	4 - 8 Jul '89
Zdravko Markov	Bulgaria	Educational informatics; artificial intelligence	USA IJCAI'89, Detroit	20 - 25 Aug '89
Vihar Zdravkov	Bulgaria	Socio-cultural impact of computerization - assessment and forecasting	Canada McGill Univ., Montreal Ontario Inst. for Studies in Education, Toronto Univ. of Waterloo, Ottawa	9 - 18 Sep '89
Rumen Nikolov	Bulgaria	Classroom experience with LOGO	Belgium EURO LOGO '89, Gent	29 Aug - 2 Sep '89
Rossen Filimonov	Bulgaria	Computers in education	Belgium EURO LOGO '89, Gent	29 Aug - 2 Sep '89

Stefan Dishliev	Bulgaria	Computer-based technology in education; computer-aided learning and teaching	United Kingdom Univ. of Lancaster	1 - 10 Nov '89
Ivan Stanchev	Bulgaria	Advanced information technology in education	USA 31st ADCIS Conference, Washington	13-17 Nov '89
Ivan Stanchev	Bulgaria	Technology & education	Belgium ICTE'90, Brussels	19-23 Mar '90
Julita Vassileva	Bulgaria	Computer-assisted instruction	Germany ICCAL'90, Hagen	11-13 Jun '90
Dencho Batanov	Bulgaria	Educational technology and informatics	Australia WCCE'90, Sydney	9 - 13 Jul '90
Rumen Nikolov	Bulgaria	Computers in education	Australia WCCE'90, Sydney	9 - 13 Jul '90
Ivan Stanchev	Bulgaria	Computers in education	Australia WCCE'90, Sydney	9 - 13 Jul '90
Zdravko Markov	Bulgaria	Artificial intelligence	Sweden ECAI'90, Stockholm	6 - 11 Aug '90
Gospodin Jelev*	Bulgaria	Educational video films with computer graphics and animation	United Kingdom TIME'90	15 - 19 Oct '90
Ivan Stanchev	Bulgaria	Computer-based instructional systems	USA 32nd ADCIS Conference, San Diego	28 Oct - 2 Nov '90
Darina Dicheva*	Bulgaria	Research and technology transfer	Italy DIDA*EL, Milano	5 Nov - 7 Dec '90
Danail Dochev*	Bulgaria	Research and technology transfer	Italy DIDA*LAB, Milano	16 Nov - 14 Dec'90

(*) Fellowhips financed by a national contribution.

ANNEX D

Equipment Specifications

	Item	Quantity	Time of delivery	Purchase Order
1	TLC Equipment for chromatography		11.87	654222.7
2	Machines a relier IBICO combine A4 PB 21	1	11.87	654239.7
3	Reliures 4.5 200 11.87			
	Reliures 11 200			
	Reliures 15.5	150		
	Reliures 25	50		
4	Couvertures Rhodoid 0.15 incolore	500	11.87	
5	Couvertures carton stony ivoire	200	11.87	
6	MIC 2000 complete software version	1	12.87	654258.7
7	MIC 3000 complete software version	1	12.87	
8	Foreuse a papier citoperforak manuelle	1	12.87	654269.7
9	Foret diametre 6	1	12.87	654269.7
10	Wheelwriter 6747 electronic typewriter	1	12.87	654238.7
11	IBM easystem correctable ribbon in dozen	1	12.87	
12	IBM easystem lift-off cassette in dozen	1	12.87	
13	IBM PC/XT 5160-499	3	01.88	654137.7
	CPU 8088,640KB RAM on board			
	1 X 360KB floppy disk drive			
	1 X 20MB hard disk drive keyboard			
14	IBM Enhanced Color display 5164-002	3	01.88	
15	Enhanced graphics adapter	3	01.88	
16	IBM memory extension card 5160-1251	3	01.88	
17	IBM Graphics memory kit	3	01.88	
18	IBM PC/AT-3 5170-339	3	01.88	
	CPU 80286, 0.5MB RAM			
	1 X 1.2MB floppy disk drive			
	1 X 30MB hard disk drive			
	1 X 360KB floppy disk drive keyboard			

	Item	Quantity	Time of delivery	Purchase Order
19	IBM Enhanced Color display 5170-0207	3	01.88	
20	IBM Enhanced graphics adapter 5170-1250	3	01.88	
21	IBM memory extension card 5170-1251	3	01.88	
22	IBM Graphics memory kit 5170-1252	3	01.88	
23	CANON Scanner	1	01.88	
24	Laser Jet II printer	1	01.88	
25	Monitor SONY KX-14CPI -RGB and PAL input	1	01.88	
26	80 colon card and 64KB RAM	6	01.88	
27	Massicot manuel MB 36 sur stand	1	01.88	654240.7
28	Lame de rechange	1	01.88	654240.7
29	Reglettes de rechange	10	01.88	654240.7
30	AG-6200E Panasonic VHS Video recorder	1	03.88	654151.7
31	Remote control unit (for AG-6200E)	1	03.88	654151.7
	Colour Video Projection system comprising PT-102 120" video projector ET-12R remote controller ET-11C30 remocon ext cable VMT-120B 120" screen (map tipe)	1	03.88	654151.7
32	Set of VHS cassettes (20pcs)	1	03.88	654151.7
33	Liquid Crystal display, software	2	03.88	654152.7
34	Lany Fax projectors		03.88	654152.7
35	VPH - 722QM video projector	1	06.88	654449.7
36	VPS 100 F1 Screen for VPH-722QM	1	06.88	
37	UGC-2 Cable	8	06.88	
38	UGC-5 Cable	8	06.88	
39	UGC-5P Cable	1	06.88	
40	VO 5850P,recorder,color videocassette	1	06.88	
41	VP 5040,player,color videocassette	1	06.88	
42	BMDP Statistical software package	1	06.88	678124.8
43	English Teaching with video on PAL/VHS	1	08.88	678126.8
44	Television English 1-6 on PAL/VHS	1	08.88	
45	MUZZY in Gondoland on PAL/VHS	1	08.88	
46	Transparent sheets A4	500	02.89	678599.8
47	Binding spyrals 25 mm	100	02.89	
48	Binding spyrals 4.5mm	400	02.89	
49	Starter Packs	7	03.89	678541.8
50	TC-O building sets	10	03.89	

	Item	Quantity	Time of delivery	Purchase Order
51	Manual Control Panels	12	03.89	
52	Universal Buggy	12	03.89	
53	Instruction course		03.89	
54	Hollow punches 6mm	4	04.89	678598.8
55	Turnable side lay	2	04.89	
56	Canon NP-155	1	05.89	678596.8
57	Hewlett Packard HP-7475A Plotter	1	05.89	
58	Interfacing	12	06.89	8805029
59	Computer control	3	06.89	
60	Construction Kits-project 2000	1	06.89	
61	Literature	19	06.89	
62	MSM-PS Software programme	1	02.89	678597.8
63	ZCALL module for ASM or C Routines	1	10.89	
64	Glace d'exposition pour Canon MD3261	1	07.89	678596.8
65	Sony Audiodiscs		89	679181.9
66	JT-FAX 9600 card FAX(Quadram)	1	02.90	679183.9
67	Epson LQ-1050	2	02.90	
68	Parallel printer cable	12	02.90	
69	2MB/4MB Memory card PC AT	2	02.90	
70	2MB memory exp.for LaserJet	1	02.90	
71	Witty Mouse C-400	3	02.90	
72	HP L/JET Toner	4	02.90	
73	Seagate ST225 20MB HDD,controler	20	02.90	
74	Seagate ST4096 80MB HDD,controler	2	02.90	
75	Archive XL	3	02.90	
76	Archive Ext	3	02.90	
77	DC600A cartridge	30	02.90	
78	3C 501 Etherlink card	8	02.90	
79	3C505B etherlink plus card	2	02.90	
80	100 thin ethernet	1	02.90	
81	INTEL 8087-2	4	02.90	
82	INTEL 80287-8	2	02.90	
83	TOSHIBA 1200, 9 volt adapter	1	02.90	
84	Floppy disk drive for Toshiba, laptop w/adapter	1	02.90	
85	Egart 860	1	02.90	
86	Taxan Multiscan display super	1	02.90	

	Item	Quantity	Time of delivery	Purchase Order
87	2MB RAM card for PC XT	6	02.90	
88	GVC Optical Mouse	3	02.90	
89	Pacific Postscript Cartridge for LaserJet II printer	1	11.90	679867.0
90	Personal Computer 386/25MHZ 4MB RAM Hard disk drive 200MB Floppy disk drive 1.2MB, 5.25" Floppy disk drive 1.44MB, 3.5" Super VGA controler card	2	10.91	683252.1
91	Super VGA Monitor	2	10.91	
92	HP LaserJet III laser printer, 3MB memory	1	10.91	
93	EP-S cartridge for HP LaserJet II	8	10.91	
94	Epson LQ1050 Printer	1	10.91	
95	Ribbons for EPSON LQ1050	10	10.91	
96	UMAX model UC-300, 24 bit color scanner	1	10.91	
97	Mouse	1	10.91	
98	SONY CD-ROM external player	1	10.91	
99	External disk drive 3.5, 1.44 MB	1	10.91	
100	Internal disk drive 3.5 1.44MB	1	10.91	
101	Lego toys and parts per specification subcontr.		02.91	

ANNEX E

Publications

1. Atanasova, St. *Plane Geometry System - a Playground Environment for Acquiring and Improving Mathematical Knowledge*. Report on Contract No. 554, 1989. (In Bulgarian).

2. Bankov, K. *Learning and Doing Mathematics*, Presentation at BISME - 2, Bratislava, 1990.

3. Bekyarova, M.& I. Nikolova. *Supplementary Manual to the Grade 8 Textbook with Solved Problems in Informatics*. S., MNP, 1989. (In Bulgarian).

4. Dicheva, D. *Intelligent Tutoring Systems: the State of the Art*, in: IIP Training Course for Educational Specialists, RCEI - BAS, Bulgaria, 1989.

5. Dicheva, D. & B. du Boulay. *Rebuilding the BLOCKS Tutor*, University of Sussex, CSRR #136, 1989.

6. Dicheva, D. & B. du Boulay. *Do What I Do and Do What I Say: an Improved BLOCKS Tutor*, in: Proceedings of the Third International Conference "Children in the Information Age", Sofia, Bulgaria, 1989.

7. Dicheva, D. & R. Nikolov. *Glass Box Toy Systems in School Informatics*, in: Proceedings of the Second European Logo Conference., Gent, Belgium, 1989, pp. 638-649.

8. Dicheva, D. & V. Stankoulova. *On Some Issues of the Domain in the PGS Tutor*, in: Proceedings of the Fourth International PEG Conference "Learning with Artificial Intelligence", Uppsala, Sweden, 1989, pp. 1-14.

9. Filimonova, T. & K. Stefanov. *Learning Prolog in High School*, Presentation at PEG'88, Copenhagen, 1988.

10. Lazarov, B. *An Idea of Using Computers in Mathematic Education*, Presentation at BISME - 2, Bratislava, 1990.

11. Martcheva, K. & Z. Miteva. *Teaching Informatics and Traditional Cultures - An Experiment*, in: Proceedings of the Third International Conference "Children in the Information Age", Sofia, 1989, pp. 5-16.

12. Nikolov,R. *Tools and Methods for Teaching Informatics at School: an Advanced Logo Course*, in: Education & Computing, North-Holland, Vol. 7, 1991. (to appear).

13. Nikolov, R. & D. Dicheva. *Introducing the Concept of Data Types Using Logo*, in: Proceedings of the Second European Logo Conference, (G. Schuyten & M. Valcke, Eds.), Gent, Belgium, 1989, pp 650-662.

14. Nikolov, R. & E. Sendova. *Can the Teachers' Creativity Overcome Limited Computer Resources*. Education & Computing, North-Holland, 1989, No.4, pp. 179-184.

15. Nikolov, R. & E. Sendova. *Informatics for Beginners*. Part One. S., NP, 1988. (In Bulgarian).

16. Nikolov, R. & E. Sendova. *Informatics for Beginners*. Part Two.,S., NP, 1989. (In Bulgarian).

17. Nikolov, R. & E. Sendova. *The Basics of Informatics*, M., Nauka, 1989. (In Russian).

18. Nikolov, R., Sendova, E. & D. Dicheva. *What to Teach in Informatics and How - a Bulgarian Experiment*, in: Lovis, F., Tagg, E. (Eds.), Computers in Education, North-Holland, 1988, pp. 427-432.

19. Nikolov, R. & E. Sendova. *Logo Language in Education*, in: IIP Training Course for Educational Specialists, RCEI-BAS, Bulgaria, 1989.

20. Nikolov, R. & E. Sendova. *Informatics for All School Ages*, Presentation at WCCE'90, Sydney, 1990.

21. Nikolova, I. *A Metaphore Explaining the Scope Rules in Logo*, EUROLOGO'91, Parma, Italy, 1991.

22. Nikolova, I. & I. Georgiev. *Logo Olympiads for Schoolchildren in Bulgaria*, in: Proceedings of the Third International Conference "Children in the Information Age", Sofia, 1989, pp 155-166.

23. Sarkissyan, P., Koeva. I. & R. Dinkova. *Communication in Computer Program Environment*, in: Proceedings of the Third International Conference "Children in the Information Age", Sofia, 1989, pp. 119-127.

24. Sendov, B. & D. Dicheva. *A Mathematical Laboratory in Logo Style*, in: Proceedings of the IFIP TC 1st European Conference on Computers in Education - ECCE'88, Lausanne, Switzerland, 1988, pp. 213-217.

25. Sendova, E. *Computers as a Stimulus for Generating Ideas, Education & Computing*, North-Holland, No. 4, 1989, pp. 151-157.

26. Sendova, E. *Exploring Language in Logo Environment*, in IIP Training Course for Educational Specialists, RCEI - BAS, Bulgaria, 1989.

27. Sendova, E. *Are There Rules for Creative-Teaching Informatics?*, in: THE Journal, 1990, Vol. 17, No. 5.

28. Sendova, E. (Eds). *Creative Teaching Informatics*, Sofia, RGE (in press).

29. Sendova, E., & R. Nikolov. *Teachers Have Been Growing Up, Computers in Education*, North-Holland, 1988, pp. 145-148.

30. Sendova, E. & R. Nikolov. *Problem Solving Scenarios in Secondary School Textbooks in Mathematics and Informatics*, in: Proceedings of the Second European Logo Conference, Gent, Belgium, 1989, pp. 650-663.

31. Sendova, E., Nikolov, R. & D. Dicheva. *Mathematics and Informatics - an Attempt for Integration in the Secondary School Curriculum*, in: Proceedings of the Third International Conference "Children in the Information Age", Sofia, 1989, pp. 155-166.

32. Spasova, M. & N. Petkova. *Publication of a Students' Magazine - Inspiration and Motivation for Creative Work*, in: Proceedings of the Third International Conference "Children in the Information Age", Sofia, 1989, pp. 175-179.

33. Stoyanova, N. & R. Radanov. *Children's Software House*, in: Proceedings of the Third International Conference "Children in the Information Age", Sofia, 1989, pp. 180-194.

34. Tzoneva, V., Lazarova, L. & Tz. Kostov. *Character of "Teacher - Pupil" and "Pupil - Pupil" Communications in LOGO-Based Education*, in: Proceedings of the Third International Conference "Children in the Information Age", Sofia, 1989.

35. Vasko, T.& D. Dicheva. *Educational Policies: An International Overview.* Anno Domini 1989. WP-89-xx. Laxenburg. Austria, Institute for Applied Systems Analysis, 1989.