Information technologies *in teacher education*

Issues and experiences for countries In transition

Edited by Betty Collis, Iliana Nikolova, Katerina Martcheva

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What do Instructional and Information Technology Offer to Teacher Education? Results and the Future

Sanne Dijkstra and Hein P. M. Krammer

Faculty of Educational Science and Technology,
University of Twente, The Netherlands

Abstract

The University of Twente offers teacher training for senior high school tea - chers of mathematics, physics and chemistry andfor teachers of higher vocational education. The profession-specif c training course for senior high school teachers is comprised of an optional two-month undergraduate preparatory period followed by a one-year graduate program. The resear - ch program of the teacher training institute shows strong interest in the use of CIT in the senior high school course program. The main issue was the design of instruction for learning to solve problems. The results of the stu - dies are used in the teacher training program. In the training courses many CIT applications are used, like practising with courseware, measurement by computers, implementing courseware in school classes.

1. Teacher education in The Netherlands

In The Netherlands separate training courses are organized

a) for teachers of elementary education,
b) for junior-secondary school teachers and teachers of junior and senior secondary vocational education,
c) for senior-secondary school teachers and
d) for teachers of higher-vocational education.

The course program for the first two groups of teachers is organised by teacher-training institutes which form a sector in schools for higher vocational education, whereas the course program for the last two groups is organised by a teacher-training institute of a university.

The training course for senior-secondary school teachers is comprised of an optional undergraduate preparatory period of two-months' duration followed by a one-year graduate program, which is divided in two periods of roughly six months each. In the first period, several classes relating to instructional technology and student motivation are taken and finished by taking exams. The second period is used for an internship with a secondary school. Those students who successfully finish the course program and the internship are licensed as senior-secondary school teachers for a subject which forms part of the secondary-school curriculum.

Because the course program for senior-secondary school teachers is offered by a training institute of a university, both research and development and the training of students form part of the program. The authors have responsibilities for the training of teachers of mathematics, physics, and chemistry.

For the rest of this paper, the term "teacher education" needs explication. The term is confined to those courses which are specifically directed to the teaching occupation, that is, directed to the acquisition of knowledge of psychology and pedagogy and their applications in teaching specific school subjects. We are aware that a complete teacher-education program also contains courses in the subjects to be taught. However, communication and information technology (CIT) applications in such courses are not typical for teacher education.

2. Research and development

2.1 Research about information technology in secondary - school instruction

The research program of the teacher-training institute at the University of Twente has shown strong interest in the use of information technology in the senior-secondary school course program. The main issue was the design of instruction for learning to solve problems. The results of the studies are used in the teacher training program. Following are some examples of this research.

2.1.1 Physics.

In the beginning of the 1980s the (stand-alone) computer was used to coach I 0th Grade students with deficiencies in prerequisite knowledge of physics. The pretest scores of some students of the schools who participated in the study showed deficiencies in metrics, trigonometry and proportions, and equations. The remedial instruction for these topics was designed as a self-instructional computer-assisted instruction. The students with deficiencies in prerequisite knowledge and skills were invited to take the remedial instruction and reach mastery. After taking the remedial instruction, the regular physics course of instruction was offered and the students were administered a kinematics test.

In comparison to a control group, short-term results were shown for the computerassisted remedial teaching. The effect was stronger if the remedial teaching was supervised. On the long term, as to the results of regular instruction, an effect can be demonstrated only for students with extremely deficient prior knowledge (De Bruijn, 1988).

2.1.2 Programming problems.

In the middle of the 1980s computer use in elementary and secondary education was planned and financially supported by the Dutch Government. It was proposed that computer science should be part of the senior-secondary school curriculum. The teacher-training institute developed projects for studying the teaching of programming in Comal and Pascal and for designing and querying a database with Structured Query Language (SQL). The solving of programming problems was the main issue.

In the first project different strategies for how to teach programming to students of Grades 10-12 were developed and tested. The "reading", the "generation", and the "completion" strategies were implemented in textbooks or in CBT-programs. A small subset of the structured programming language COMAL-80 was used. For the procedural instruction the results of the study showed that the completion strategy was superior, for the overall instruction the reading approach is recommended. Showing a concrete computer model early in learnmg and providing the students with a general design schema are important tactics for declarative instruction (Van Merri_nboer, 1990).

A similar project was developed to list syntactic and semantic bugs in PASCAL programs and to provide intelligent feedback on semantic errors. For this purpose, a PASCAL textbook and a diskette with problems was developed. Regular discussion with senior-secondary school teachers about the content of the textbook and the programs was realized. For the intelligent-feedback program, "Program Understander for Students" (PROUST), an intelligent-tutoring system (ITS) was used (Johnson, & Soloway, 1985). Co-operation and information about the use of the ITS with the designers of the program was realised by electronic mail. The ITS ran on a minicomputer which was located at the teacher-training institute. The secondary-school students used a personal computer to test the programs they designed. For datacommunication the telephone network was used. The hypothesis that immediate feedback from the ITS should be superior for the identification and repair of bugs in Pascal programs in comparison to non-immediate feedback of a teacher could not be confirmed. (Dijkstra, Krammer, & Maaswinkel, 1989).

Studying the teaching of programming was continued in schools for higher vocational training and not with senior-secondary school students because, on a national level, the decision was made not to include teaching programming in the generalsecondary curriculum.

2.1.3. Data base query problems.

The teacher-trainmg institute further started a project to study the differential effects on learning outcomes of two instructional strategies, a top-down and a bottom-up approach, in an introductory course on solving data base query problems. For this project a course book and a workbook were written. The books were available in separate versions for the two approaches. After finishing the course program an achievement test was administered. It was hypothesized that for high-ability students the top-down approach will be superior to the bottom-up approach, but for low-ability students the bottom-up approach will yield better results. For low-ability students the data support the hypothesis. For high-ability students however, presenting different problem-solving strategies did not result in significant differences in learning outcomes (Van Dijk, 1992).

2.1.4 Chemistry.

The training institute further developed computer-assisted instruction to offer students a set of heuristics to solve interpretation problems in chemistry. The purpose of the heuristics was to strengthen metacognitive skills. The students appreciated the presentation of the heuristics, but in some cases were not pleased about the dosage of heuristics. (Kramers-Pals, in press).

2.2 Co-operation with the schools for research and in practice

The overview makes clear that the teacher-training staff uses information technology for research and development purposes. The projects are carried out in co-operation with the senior-secondary school teachers who supervise the interns. The computerassisted or computer-managed programs and the course books are sometimes published or can be purchased at the institute. Thus the use of information technology serves both the research program of the institute and the course programs of the schools. For the near future the research and development program will be continued. Further developments in the co-operation with the schools can be expected if the development of software and courseware can profit from improved communication networks.

3. Training students

Applications of CIT in a teacher-education program are necessarily limited. By nature, teacher education contains primarily training situations in a social context. Below, we present an overview of the major applications illustrated by now existing or in the future desired examples from our program.

3.1. Knowledge about relevant IT systems

Teachers should know about existing IT systems applicable in their teaching situation. Our mathematics students practise with several programs in use at schools, for instance drawing diagrams, computing statistics, or designing dynamic systems. Our physics students practise with software and hardware with which measurements can be analysed.

3.2 Implementation of courseware

Prospective teachers have to learn how courseware can be implemented in school: have to learn how to evaluate courseware, how to organize groupwork with computers, etc. Students of our university have to practise the implementation of courseware. For instance, last year students wrote lesson materials, and designed and conducted a series of lessons in Grades 10 and 11 using the courseware program DERIVE.

3.3 Lesson design.

In teacher-education courses students are required to spend much time designing lessons, much more than expert teachers do. It is assumed that such activities - which require the student to specify objectives, to analyze the learning tasks, to generate examples, etc. - speed up the acquisition of pedagogical content knowledge. For such activities automated instructional-design tools are being developed that will become available in the near future. At the moment we use a demonstration version of tool based on Gagn's Instructional Event Theory.

3.4 Decision making and reflection

To further the teachers' skills in decision making and reflection, case-based teaching has become an important method in teacher-education courses. Recently, case-based computer simulations and games have become available. A new and promising development is interactive video applications to train teachers in rapid decision making.

3.5 Improving teacher-education curriculum.

The teacher-education curriculum could be improved using a computer-managed instruction strategy. As our students enter the program at different times in the year it is impossible to organize the courses in classes. Computer-managed instruction in combination with a module-based program makes individual learning paths of student possible.

3.6 Communication network

A further improvement of the curriculum could be reached if the co-operating schools could be connected with our university in a communication network. This is not just a practical possibility to speed up the messages between the schools and the university. It also can improve the mutual understanding of co-operating teachers and university faculty regarding the training goals. This small overview shows the possibilities of CIT in the teacher-education curriculum and the applications which are already available now.

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