SCHOOL INFORMATICS IN LOGO STYLE: A TEXTBOOK FACING THE NEW CHALLENGES OF THE BULGARIAN INFORMATICS CURRICULUM

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Abstract

The paper deals with a textbook "Informatics in Logo style" for the Bulgarian secondary schools. It is written in the context of the significant changes Bulgaria is facing today which have influenced the whole school curriculum. An estimation of the advantages and the shortcomings of a previous version of the textbooks "Mathematics and Informatics for 8-12th grade" in which mathematics and informatics have been in a closer integration is presented. The new textbook is based on the informatics topics of "Mathematics and Informatics" taking into account the implications of transferring on a larger scale the positive results from a now 10 year old educational experiment in integrating informatics into the curriculum from the junior high school. In proposing to work in Logo style, the authors believe that the dilemma *programmers vs. users* could be solved in an elegant way.

Keywords

Informatics curriculum, integration, Logo, glass-box toy system

1 Introduction

The problem of specifying an informatics curriculum matching the educational demands of various countries in various circumstances has been a real challenge for the specialists in the field. A very successful attempt to solve this problem is *Informatics for secondary education: a curriculum for schools* produced by a working party of IFIP under the auspices of UNESCO. This curriculum *is designed to be capable of implementation throughout the world to all secondary age students* [1]. The experts have designed the informatics units and modules on the basis of their wide experience of developing effective informatics education during the past quarter of a century. But it is only natural that solving such a complex problem gives rise to other problems:

- What software to use so as to cover all the informatics education objectives ?
- How to overcome the variety and the complexity of using the commercial application software packages at school?
- How to help teachers to address learners with different interests and motivation?
- How to overcome the variety of conditions in schools which are at different phases of development although in the same country?

The purpose of this paper is to give possible answers to some of the above questions taking advantage of authors' experience in teaching Informatics in the Bulgarian context.

2 Background

Bulgaria has a relatively old tradition in having informatics in the secondary curriculum. The first steps go back to 1967 when programming was included as a separate subject in the curricula for the mathematical schools and in the special mathematical classes in some other schools. The first textbook, addressed mainly to teachers of informatics, appeared in 1974 and included a short preface on the theory of algorithms and an elementary idea of machine languages, illustrating concepts from the algebra, geometry and numerical methods [2]. With the introduction of the microcomputers in the schools on a large scale (1984 - 1986) different educational strategies have been experimented including such ambitious projects as the Research Group of Education (RGE) projects on integrating the school curriculum on the basis of informatics. (In the latter the computers were introduced at the junior-secondary school.) [3,4] Based on the positive experience of the RGE informatics project, a team of researchers (including the authors of this paper) wrote in 1987 textbooks named *Mathematics and Informatics for high school students* (8th -12th grade) for the general educational system. These textbooks have been in use since 1988 in many regular secondary schools. Several university courses on school informatics for future teachers have been based on them as well.

Some General ideas adopted in *Mathematics and Informatics* textbooks are:

- *Integrating informatics with other school subjects, mainly with mathematics* has been expected to be very useful for both informatics and the concrete subject matter since:
  - informatics offers a means to clarify and extend the mathematical concepts studied and to illustrate the possibility of applying them to real situations;
  - informatics offers appropriate tools for obtaining a great variety of solutions;

  - working in a computer environment of exploratory type (such as Logo and its extensions) contributes to anticipating school mathematics as a field for investigations and to enhancing the scientists into the learner [5];
- *Using problem solving scenarios* developed both vertically (in grades) and horizontally (with the same grade) [6];
- Specifying branches in mathematics, informatics, linguistics and arts which students could choose according to their own interests;
- Offering the 'transparent software' approach through glass box toy systems [7].

3 Lessons learned

The most recent COMPED study reveals most of the problems in the Bulgarian schools (need for updating the computer equipment, for good educational software and textbooks, for re-training teachers etc.) [8] That these problems are a serious reason for the fact that the textbooks have not brought in life their full potential, is rather obvious. As authors we were more interested to see what were the advantages and shortcomings of the textbooks when used by experienced teachers in appropriate technical environment. What follows has been extracted from observations and discussions with such teachers.

The idea of having preliminary 2-week period of intensive work with Logo (aiming at a more fluent transition to using it as tool) could not be achieved. Thus even teachers who were competent informaticians found it difficult to use informatics tools for illustrating mathematical notions since the tools themselves needed mastering. Besides the idea of integrating informatics with mathematics (or possibly with other school subjects) worked well mainly when the informatics classes preceded immediately those of mathematics. *You do - you understand, you explore - you invent* was the principle applied. Having once experimented with mathematical objects in Logo (or Logo-based) environment pupils were better prepared and motivated to prove theorems. Practically though this would mean dividing the form (usually about 30 pupils) in 2 groups for the informatics part and finding another appropriate configuration (e.g. learning foreign language) to make a shift with. Similarly - when integrating informatics with other disciplines (like languages and arts). Furthermore, in this case, teachers in informatics had to joint the subject-matter teacher or the latter should be trained additionally. With the smaller number of pilot schools, highly motivated teachers and researchers to support them, this idea worked reasonably well. But when attempted on a larger scale the problems faced multiplied: for the sake of better integration some mathematical lessons in the textbook were re-arranged differently from the classical tradition, thus making the novelty too big for the mathematics teachers (for them even the attempt of integrating geometry with algebra was quite a step, since till then these were two different school subjects with separate grading). As a result very often the informatics topics were left to the informatics teacher thus reducing the chance for a real integration. The informatics teachers on their part (especially in the case of non-mathematicians) did not like the limitations imposed by mathematics lessons, or by the project scenarios - they would prefer a more systematic introduction of the informatics topics. The exploratory spirit of Logo where debugging sometimes is substituted by *de-goaling* confronts with the rigid time-table of the regular classes in informatics. Last, but not the least, there is still prejudice among a significant part of the education society (including some parents) that Logo is a *children's* language and consequently students in the secondary school should learn something more professional, like Pascal or C++.

4 The new textbook

Despite the technical, organizational and other problems encountered in using *Mathematics and Informatics* these textbooks became popular and were appreciated by most of the teachers and loved by the pupils. This was the reason for considering the idea of developing a new version meeting the challenges of the new economic situation in the country, in general (and those of the Ministry of Education, in particular). The new textbook entitled *Informatics in Logo Style* [9] takes into account the lessons learned and a good deal of teachers' recommendations. This step was by no means giving up the idea of *marrying* Logo-informatics and mathematics. It wasn't a *divorce.* It was rather getting wiser after several years of *happy marriage*.

4.1 Requirements

The idea for the *Informatics in Logo Style* was that it would be an alternative of the textbook "Informatics with Pascal" which was recommended by the Ministry of Education as a basic textbook for the 10th grade school subject *Informatics* [10]. The Ministry asked the authors to write the new book so that it could cover in addition the optional informatics courses in the junior high school. Eventually, the new textbook had to be a Logo based Informatics book for students from 5th to 10th grade (11 to 16 year old students) in different forms of training at school: regular, optional, and extra-curricula activities. This was quite a challenge.

4.2 The Design Principles

As its title suggests, the textbook was not meant to be an introduction to Logo programming but an introduction to Informatics in *Logo style.* This means that it would hopefully bring the spirit of the educational philosophy of the Logo community, which sees learning as a constructive process.

When thinking of a school informatics curriculum we should mention the two common perspectives: to prepare students for computer programming jobs or to help them become competent users of informatics tools. Neither of these perspectives in its extreme form seemed to us satisfying from educational point of view. In the informatics classes the students should not *learn to program* but rather should *program (in order) to learn.*

In our view the school informatics should pursue two main goals:

- to introduce the basic concepts, formal structures and methods of informatics;
- to acquaint the students with various computer applications in the real life.

An elegant way of achieving these goals is to bridge the gap between the two extreme approaches *programmers* vs. *users*.

Based on the view of recognized researchers in the field and on our personal experience we consider as important three stages in students' study of informatics. In the first one they must learn the *rules of the game*, i.e. the syntax and the semantics of the programming language (see also [11]). At this stage the novices need much practical experience. At the second stage the students get acquainted with ideas, formal structures and methods of Informatics. At the last stage the goal is twofold. On one hand - to give the students an idea of reasonable use of computers in various fields, on the other - to make them familiar with the basic principles of developing computer systems.

4.3 Contents of the Textbook

The textbook is structured in three modules corresponding to the considered stages of studying Informatics:

1. Introduction to Programming
2. On more serious informatics topics
3. More informatics and applications

The *user-friendliness* of the Logo environment was naturally transferred into *user-friendly textbooks.* In the **introductory part** we have minimized the formal presentation and the technical details and provided in a meaningful context even the *unfortunate necessity* of learning the rules of the programming language. This module starts with brief historical information about computers and programming. Then some basic concepts such as commands, loops, variables, procedures, recursion, conditionals and Boolean expressions, words and lists are introduced using the Bulgarian version of Berkeley Logo. The presentation is based on examples which serve as a skeleton for developing informatics ideas. Such an example is a spiral procedure where we start with a tail recursive rectangular spiral and proceed with stepwise enrichment by introducing: inputs for the angle and for increasements; then - a stop condition, and finally - complex logical expressions to check the data validity, i.e. to make the procedure *foolproof.* The co-ordinate turtle is introduced intentionally late so as to support cultivating a more geometrically consistent programming style in which absolute and relative positioning of the turtle are not mixed. (This observation has been triggered off by a remark of Sean Close's.)

The **second module** deals with *more serious* informatics topics. The importance and the role of the local variables is considered as opposed to that of the global ones. Then the embedded recursion is introduced by both a graphical and a word version of a typical recursive problem. To reveal the most essential features of the recursion we involve this concept in different contexts: word and list processing, number problems and fractals. Further on the most common data structures are discussed: *list, array, set, queue, stack.* Finally, such important informatics topics as sorting, searching and coding of information are included.

The **third module** contains three branches which could be used by preference: (i)Informatics; (ii) Arts and design applications; (iii) Linguistic and natural language applications. In the first branch we give high priority to the approach of using *glass-box toy systems*. These are simplified models of computer systems such as *data base systems, electronic dictionaries, spreadsheets,* etc. Students could use such systems as *a black box* to experiment with and thus to get an idea about their functions. Furthermore, the texts of the *glass box* toy systems are available to the interested readers and can serve as *windows* to a more penetrated study of the software implementation principles. The remaining two branches are meant *to those who think they don't like the subject.* Working in a field of their own interest (arts, design, linguistics) would hopefully raise the motivation of pupils and would let them choose their own way towards making best use of informatics.

5 Conclusion

Our strong belief is that Logo is the language of choice for secondary school informatics. Logo is more powerful and cleaner than Pascal and directs the learner's attention to interesting issues, rather than to syntactic details and implementation concerns [11].

When working on the textbooks it was a great advantage for us to develop them together with a relevant software environment. Some educational metaphors have been visualized and brought into life through an appropriate interface. Several consecutive versions of Logo in Bulgarian have been developed in parallel with the development of the textbooks.

The modular structure of *Informatics in Logo Style* will hopefully meet the requirements for usability at different age and different level of programming knowledge and skills. Thus its first part could be used by younger children in the optional primary level IT course (12-14-year old students). The first and the second parts could be used in the regular informatics course at the secondary school course (16-year old students). The third part offers material for the optional secondary level IT course (16-year old students).

The future perspectives of *Informatics in Logo style* are in harmony with the Logo spirit: *no threshold, no ceiling* in 3-Dimensional space:

- *contents*: extensions of the elective modules (both in variety and in volume) have been envisaged;
- *software:* the supporting software environment will be enriched with new glass box toy systems and microworlds;
- *authorship*: The authors of the textbooks see themselves as a part of a broader team (teachers, students at university and school level) endeavoring to improve and further develop the textbook and the supporting software.

Development in these dimensions will hopefully contribute to the achievement of educational informatics goals as formulated in [1].

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Theme: Methodology in Curiculum Content Areas

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