

Distance Learning Courses in Computer Science – Initiation and Design

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Abstract

Nowadays adapting the computer science courses to conform the specificity of distance learning represents an important trend as it concerns the offering of quality learning content. The paper focuses on some didactical issues that relate to the development of distance learning courses for university education in the area of computer science. The experience gained by the authors of delivering similar courses in different Bulgarian and foreign universities makes possible to determine their specific demands, subject range and proper get-up suitable for distance learning.

Key Words: *distance learning, computing*

1. INTRODUCTION

Recently with the very rapid development of information and communications technologies the demand of knowledge and various computing skills in business and social activities is growing up. In today's global and competitive environment which is marked by the coming of Information society, knowledge and the way it is deployed by organizations, represent the unique source to gain a long-term competitive advantage. The Information society imposes on technology enhanced learning and teaching at different educational forms and levels. Consider the difference between educations in mathematics and computer science. The education in mathematics preserves its traditional forms and objectives while the education in computing exhibits a continuous change of the learning content and serious requirements for working knowledge. Education in computer science is dynamic because of the advances in information technologies. Nowadays the meaning of the term 'computer literacy' is quite different than fifteen years ago.

Speeded development and deployment of information technologies impose adequate changes in computer science curricula for all educational degrees. The proper and immediate professional recognition of graduated students determines the trend towards a pragmatic education. Creating distance courses in computer science represents a high priority activity. This activity makes for an increased quality and permits to diversify educational forms both in higher and professional education. Besides regular education, universities also differ in their strategies when develop and offer distance learning courses. In any case, covering a whole subject area with distance courses is regarded as a long lasting process where the efficiency becomes a predominant factor. So, considerations about: selecting the most appropriate courses for this kind of education, determining the most suitable and effective learning activities, planning the learning content and its delivery are very important.

In this context the main goal of this paper is to focus on some methodological aspects that relate to the development of computer science courses for distance learning. We discuss how to adapt the computer science courses for distance learning, their scope and the orderliness of learning content. The technological issues concerning the Web based delineation of such courses as well as the management of the overall learning process lie beyond the scope of this paper.

The leading software developers usually offer different kinds of company's tutorials, manuals, etc. Even in the traditional form of education, because of the dynamics in computing, we stimulate students to use these extra resources, so as to obtain a certificate for a given product. This additional specialization could be achieved via self directed or distance learning.

Therefore delivering properly designed educational resources and offering different forms of education – distance, self directed or blended learning, is an important and economically motivated activity. The choice of the proper teaching methods depends on:

the form of education - distance or other type of education, and the type of learning - self or collaborative learning.

Certainly modern education is implemented as e-learning thus representing a special form of e-commerce. However there is an attempt to transfer directly some of the techniques applied in traditional education, e.g. a dynamic change of the separate learning activities or even management of the individual learning process, into distance learning. E-learning leads to temptation to leave out of account that the success of a given distance learning course depends strongly on the trainee's self-dependent work with the available learning content. That's why we find that the selection and the get-up of the learning content are rather important. We state here for self-directed learning as a process without or with minimal help from the instructor.

Our proposals concerning the topics mentioned above are based on:

- more than ten years of experience of delivering learning content in computing in different Bulgarian and foreign universities;
- author's experience in delivering distance learning course via Blackboard [1];
- author's work in the project "Leonardo Upskilling UML"[2].

The rest of the paper is organized as follows. In Section 2, we discuss the features of distance learning courses in the area of computer science for university education. Section 3 focuses on the scope of the distance learning courses. Section 4 deals with the organization of the learning content. We summarize our results in Section 5.

2. FEATURES OF DISTANCE LEARNING COURSES IN COMPUTING

At present there is a trend to interchange and combine full-time with distance form of study. This tendency seems to be a substantial component of the educational policy of many leading universities. Following its educational policy, New Bulgarian University has announced diversification of the regular education with distance courses everywhere if and as soon as possible. In computing, this activity appears to be very important because of the following considerations:

- Information technology assists all kinds of businesses by improving the efficiency and effectiveness of their business processes, managerial decision making, and workgroup collaboration thus permitting them to take competitive positions in the dynamic marketplace;
- Information systems have become a key element of successful businesses as they are considered a major functional area in business operations;
- Web-enabled systems have become a necessary factor for business success in today's global environments.

Currently, New Bulgarian University offers well-conducted programs for full-time study in computer science and network technologies [3]. However, our distance education in these domains starts from scratch. Initially we had to elaborate several distance courses as an alternative to the regular ones and then we widened the nomenclature of diversified courses. Thus, the possibilities for part-time study have been expanded significantly. The final objective is to attain mutual exchange among regular, part-time and distance studies – for separate courses and for a whole program as well, i.e. to deploy blended learning over the whole education.

Full-time study in computing could benefit from different courses delivered as distant courses. On one hand various online resources, e.g. course-wide content, quizzes, real world cases, electronic presentations, etc. have been offered. The suitability of these resources for self-directed learning is important for the decision whether to deliver a given course distantly. On the other hand, the organization of the overall learning process tends to be network based. Bearing this in mind, the degree of teacher's visibility and the own trainee's enterprise when he/she uses the learning resources become crucial. It appears

relevant permitting to a great extent a self-dependent work with the learning content. In this context distance learning relates to self-directed learning. As a result, blended learning furthers student's mobility and appears feasible, thus giving advantages to organize bendable educational process. In addition distance learning courses in computing could be especially tailored to the knowledge workers in SME [4].

When deliver given courses in different forms, the specificity and advantages of each form should be observed. For example, the regular (in class) education offers more stimuli for learners and a possibility to change learning activities dynamically. That possibility is missing or appears to be restricted in distance learning. However the latter offers the convenience to learn in a proper time and place. This feature implies the possibility to access the learning content and to interrupt the work with it in a random way. Thus, learning activities, main memorizing techniques and content granulation in a distance course should be correspondingly designed. With these considerations in mind, designing small learning units that contain a short theoretical basis, examples and tasks to be performed, appear to be most suitable in distance education. But in this way, the unreflective learning style [5, 6] would be in favor of. To tolerate different learning styles, free access to all learning units and their components is to be allowed. At the same time the overall learning process could still be managed via suggested orderliness of the learning content.

Despite the modern communication channels, the overall learning process via distant courses could be characterized with the following drawbacks:

- limited feedback "trainee- instructor";
- limited communication among the trainees;
- restricted capabilities for current assessment.

Our experience demonstrates that the success of a distance course depends on the self-motivation of the learner. Students definitely demonstrate their interest in courses delivering working knowledge because of the immediate application of these knowledge and skills in their future positions. As a result, the trainee's self motivation, self-dependent learning and self-control attain a key significance. It appears that practically instructors would not have the possibility to manage the individual learning.

In addition building learning content in computing suitable to both forms of education – full-time and distant, and meanwhile delivering courses with a limited academic staff inevitably put the efficiency as a matter of issue. Yes, it is true that during a distance learning course the instructor spares time. The 'in class' work is missing, but all the other supporting activities are quite time consuming and there is much 'writing' work. Modern communication technologies encourage the direct transfer of methods and approaches from face-to-face education into distance learning. As things stand, the main specificity of distance education is that it strongly relies on the student's self-dependant work with the learning content. We put together our considerations and proposals around this main feature.

Possible ways to concentrate efforts and reduce works when preparing new distance courses are as follows:

- prescribing learning activities suitable for self-dependent learning;
- minimizing the trainee's guidance via properly organized learning content;
- choosing proper courses/topics where these tricks would be most effective.

Taking into account the features of distance learning courses in computing we also set the following tactical goals as they concern the overall educational process:

- to build working knowledge and skills;
- to link fundamental subjects and modern technologies;
- to use the advantages of distance learning effectively;
- to make possible different learning styles;
- to suit the free access to the learning content.

These goals are determined by the current state of the computing curricula. Multiple basic courses like Programming languages, Databases systems and Networking, to name a few, would be practically useless without illustration via proper software products. The leading software developers popularize their new products and technologies by delivering different tutorials and other learning materials. There is no doubt that the new software and firm technologies should be represented in the curricula to a reasonable extent.

Taking into account all these reflections, in the next section we give reasons for the choice of some basic learning activities and the scope of the distance learning courses.

3. SCOPE OF THE DISTANCE LEARNING COURSES

A reasonable question arises: whether it is feasible to deliver all the courses from a computer science curriculum as distance learning courses? Recall, that we presume a task-based, self learning educational process. It is worthy to mention explicitly that our considerations concern the initialization of distance courses and the primary design of their learning content. The problem is which regular courses could be offered distantly and how to perform this transformation from didactical point of view.

Consequently the task to adjust fundamental subjects e.g. calculus, discrete mathematics, statistics, for distance learning can be arduous. The target knowledge of the fundamental courses usually is more abstract and its successful acquirement depends on the close interaction between the lecturer and the students. Observing the reactions of the learners, the instructor assists the creation and internalization of the new knowledge. In distance learning this interaction is some how limited. Despite the possibilities of the modern communications, the resulting feedback to build-up new abstract knowledge effectively is slight. This is the reason to postpone the launching of fundamental subjects in distance form.

At the same time company's learning content stresses on case studies, practical examples and ready solutions thus stimulating self-dependent learning. That's why we can deduce that the courses being suitable for distance learning deals with application of basic knowledge acquired in fundamental subjects. We consider courses like Practice of Programming (the language may vary), Practice of Databases, Programming Computer Graphics, and Network Applications as the most suitable to be delivered in distant form. Their learning process can be organized as task-based, but it has to be preceded by theoretical foundations, briefly exposed in the learning unit itself or/and referred to previous courses. The prescribed tasks are supposed to be performed using advanced facilities and technologies, such as modern IDE's, DBMS etc. On the other hand, the use of fundamental knowledge is reinforced and thus tightened up. In this way, the selection of proper courses to be offered distantly conforms to the goals stated in the section above.

One could argue that the learning content delivered by leading software developers fits directly for full-time study. This content almost is built entirely by examples and tasks, thus enabling unguided learning. However company's materials, e.g. tutorials, handbooks, etc. exhibit the following peculiarities:

- all facts concern a specific technological solution;
- they concentrate on mastering an enormous quantity of data;
- no associations with theoretical knowledge in computing.

Their direct use with academic purpose is inappropriate by many reasons, but these learning resources are convincing for the effectiveness of example- and task- based self-dependant learning. The exact use of company's materials exhibits didactical discrepancies consisting with low cognitive levels (reproduction and application). As a consequence, limited possibilities to attain higher levels (analysis and synthesis) exist. This justifies our opinion that in academia instructors can not rely on those materials only.

4. LEARNING CONTENT ORDERLINESS

The learning content can be organized and offered in different ways and via various learning environments. However the granularity of the content is a characteristic that is to be discussed separately, regardless of possible learning guidance and recommendable learning paths. The size of the learning unit has to allow easy memorization, thus facilitating multiple access and interrupts when using the content and improving the current learning outcome. We stand here for a maximal decomposition of the content, so that each unit can be accessed with a positive outcome (memorization) after no more than 30 minutes work on it. The instructor's professional experience is a key factor in building optimally sized learning units.

Another general consideration is about the trainee's access to the content as a whole. Whether this access is to be controlled or not? Our opinion is that possible learning paths are to be recommendable only, not restrictive ones. The reason is that learners could possess previous competence and/or a prior access to separate topics of the course he/she is particularly interested in. If so, the objectives and outcomes of each unit should be explicitly announced.

Another specific problem when offering distance courses is the coherence with all other courses in the program. We can't expect that the learner enters the course fully prepared and equipped with all needed background knowledge. Oppositely, the academic knowledge without experience tends to dissipate. So, in order to assure the learning outcomes, the exposition of the content should be self-contained at maximum.

Having in mind these considerations presented above, we propose the following principles to be followed when composing learning content:

- small, but complete learning units, facilitating multiple interrupts during the work with the content;
- explicit declaration of prerequisites and deliverables for each unit, to facilitate the self-navigation of the learner through the content according to his/hers own competence;
- minimum references to other courses and facts outside the content, thus reducing the dependency of casually missing knowledge; instead, short context related definitions and explanations can be included, if possible.

The structure of the content can be built by applying the well-known modular approach. This approach has been verified in our own experience of more than ten years teaching practice. With aim to conform the principles mentioned above, it is adapted as follows:

- the content is composed of modules, each one being sized approximately to one lecture;
- each module contains: prerequisites, outcomes, keywords, theory, examples, tasks, thesaurus, references, problems for self-assessment;
- the learning unit is a part of the module and can be either theoretical (explanation) or example and problem (task to be done);
- each example-problem unit has prerequisites and outcomes and can contain additional explanations (if needed);
- example-problem units can have upgrading sequence (if needed) or be independent, this is declared in the prerequisites;
- theory units can contain answered questions and problems for self-assessment.

Implementing this structure is the first step to be done by the lecturer, having already developed the content of a regular course. Our experience shows that this apparently simple task is also a very time-consuming process, especially when constructing upgraded example-task learning units. The main didactical issue is how to retain the unit volume in

admissible size when the complexity grows. One possible approach is to include a prior solved problem as a sub-problem in the next unit.

The learning content prepared in such a way is alike suitable for both traditional and Web-based distance learning. The latter offers incomparably more possibilities to shrink the discrepancy between regular and self-dependant learning. The use of learning management systems is an example of this, but in fact it is an extensive technological upgrade of the ground didactical activities.

5. CONCLUSIONS AND FUTURE WORK

In this paper we discuss the first steps when approaching a huge project to diversify with distance forms the whole educational program in such a dynamic domain as computer science. The solution we propose and the attempts we made are driven by our conviction that distance learning in computing is a first-priority and with a significant social impact activity. Our efforts are concentrated around the problems which courses would be most effective in distance form and how to build them. We don't touch the issue how to deliver these courses to the learner. In this sense, our attitude to the problem is more traditional than modern one.

The most appropriate university distance courses in Computer Science are those applying learning by examples and tasks. We propose to begin with courses which represent a practical application of fundamental knowledge. For all other courses the distance form could be firstly offered partially, as an alternative or as a supporting resource. The modular structure, consisting of maximally independent learning units is a proper format for initial design of the learning content, facilitating the learner's work depending of his learning style, current knowledge and momentary condition. Such prepared learning content can be used for both traditional and Web-based distance learning.

Our future work targets the development of a set of courses into distance form, thus proving convincingly the capability and efficiency of our approach. Surely, we will implement our courses via the e-learning environments that are available in our university. Further we will try to achieve computer-aided guidance through the courses, diversified learning content and adaptive e-learning.

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