THE POSSIBILITIES OF COMPUTER BASED CURRICULUM DESIGN IN HUNGARIAN HIGHER EDUCATION

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Abstract

The implementation of credit point system was an important step in the process of modernisation of Hungarian higher education. The traditional training system has ceased with the appearence of modular elements and optional courses. With the appearance of credit point system there was necessary to change the process of curriculum design. The former, fixed curriculum tables were substituted with recommended curriculum tables to help the students in the individual planning of studies. The paper describes the possibilities of computer based curriculum design in Hungarian higher education: curriculum analysis, curriculum development, course development, individual curriculum (study) planning and starting of a new field of study.

Keywords: vocational training, higher education, curriculum analysis, curriculum design

1 Introduction

The implementation of credit point system was an important step in the process of modernisation of Hungarian higher education.[1] The Hungarian credit point system has the following attributes:

- The weekly timetable.
- The maximised length of time of studies.
- The semester-based instruction.

Because of the weekly time-table the number of contact hours of lessons of individual subjects per week has to be invariable. The length of time of studies is maximised, that is there is an upper limit to take the certificate. Because of semesters the subjects are composed from semester-long parts, that is the minimal duration of a course is a semester.

In this paper we describe the possibilities of computer based curriculum design in connection with the Hungarian credit point system. These possibilities are: curriculum analysis, curriculum development, course development, individual curriculum (study) planning and starting of a new field of study.

2 The constraints of automation

Automation is the use of equipment and machines to do work previously done by people. Automatism is an operation accomplished mechanically without human action. Automatism in cognitive science means a repetitive action, which is coming off without major demands on working memory.

Automation has two definitions, one strong, the other weak. The strong definition takes automation to mean the replacement of human activity. The weak definition casts automation as support for a human agent, who is in control. It is possible to reconcile these two views, if we take into account the grain-size of the activity involved: replacing human agency in some sub-tasks of a process is a way of giving support. [2]

Automation of instructional design in the strong sense would be the automatic transformation of a list of training objectives into a specification of a sequence of instructional events. In the weak sense we can conceive of tools (such as a computer based instructional design adviser) which relieve some of the cognitive burden on the instructional designer and contribute in making design more efficient and enjoyable. We think that the week sense is more applicable in instructional design.

There are usual motives to automation: the process is routinary and costly. Instructional design contains routinary tasks, but the process is not routinary as a whole. In instructional design routine tasks are rare: these occur rather at the repeated implementation of existing plans. Instructional design is not costly in financial terms, designers are rarely paid prohibitive salaries.

In instructional design there is a need for human control. [3] The task of an automated tool would not be only to carry the bureaucratic burden of the process. Such a tool would need some intelligence or expertise too. It would play a role in more parts of instructional design, not only in boring tasks. An automated tool could advise developers to solve their problems arose.

There is an evident need for an intelligent tool, which could accomodate the relevant instructional design expertise to users with different qualification. Instructional design is generally made in higher education by instructors without adequate pedagogical training. However, instructional design expertise has a basic importance in the selection, arrangement and delivery of subject matter. Without instructional design expertise there is a minimal chance of practical expedience of prepared instructional documents.

Intelligent tools nowadays are computer based tools. That is, computer programs are performing routinary tasks and are giving expert advise if it is needed. In the credit point system based Hungarian higher education there are a lot of possibilities to build intelligent tools to help curriculum design. These possibilities in our opinion are: curriculum analysis, curriculum development, course development, individual curriculum (study) development and starting of a new field of study.

In the last years under our guidance was developed a series of such computer based tools. These tools are prototypes, they are not commercial products. They serve only research purposes. Their role is to gather experiences about the action of intelligent tools in curriculum design. In the following sections we describe the main characteristics of these computer based tools.

3 Computer based curriculum analysis

An important task to maintain existing curricula is curriculum analysis. There are well developed methods to analyse curricula using exact methods of graph theory. The curriculum is considered here as a directed graph. The elements of a curriculum can be viewed as the nodes of a directed graph. The relations of the nodes can be given in a concise form by the adjacency (relation) matrix of the graph. The curriculum may be a set of subjects, or a set of themes of a subject.

In the early eighties we had developed a mainframe based software for curriculum analysis. It had been written in FORTRAN[1]. This software used graph algorithms to determine logical contradictions, connectivity, sequences and rank functions. Its use needed computer programming expertise, so it was not applicable for computer illiterate persons. Only the advent of graphical user interface made posibble to build a user friendly software for curriculum analysis.

In 1999 a curriculum analysis tool was developed under our guidance as a diploma project. This tool uses graph algorithms too. The software analyses the curriculum according to the following points of view: determination of logical contours, examination of connectivity, sequencing, calculation of rank-functions and cliquing. This tool has a user-friendly, Microsoft Windows 9x based interface. It was written in Borland Delphi[2].

To test the the possible logical contradictions of the curriculum we use the well-known simple algorithm of the Russian I. B. Morgunoff[3]. If logical contradictions are found, then we have to eliminate them by

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[2]Szeder, L.: Tantervek elemzésére szolgáló programcsomag kifejlesztése, diplomamunka, SZIF, Győr, 1999.

[3]Morgunoff, I. B.: Primenyenyie grafov v razrabotke ucsebnüh plan, Szovjetszkaja Pedagogika, 1966, No. 3.

modifying the structure of the related elements. We have to transform the elements so, that they don't have common parts closing a circle (that is, use only new concepts with their definitions).

To test the connectivity of curricula we use the algorithm of the Hungarian L. Lovász and P. Gács originally prepared for the analysis of non-directed graphs (path searching)[4]. If non-connected parts are found in the curriculum, then we have to examine the relations of the elements. Only subjects belonging to general education may be separate parts in a curriculum of vocational training. Any other case is signing a design error.

To sequence the elements of a curriculum (the chapters of a subject) we use three methods: the modified algorithm of Morgunoff, and the T and Z algorithms of the Hungarian F. F. Gyaraki[5]. The different sequences are comparable and selectable using the indices of solidity, closeness and completeness. [4] If a sequence of the elements exists, then the graph is free from contradictions. That is, the sequencing states, as a by-product the existence of logical contradictions in the graph.

To calculate the rank functions of the graph we use the raw and column vector algorithms of the French G. Demoucron, originally prepared for operations research purposes[6]. The subjects of a level of the rank function have no relations to each other, that is they may be taught parallelly without synchronization. If the rank functions are existing, than the graph is free of contradictions. That is, calculation of the rank functions states, as a by-product the existence of logical contradictions in the graph.

Of course, in the practice there are more levels in the rank functions than the number of terms (years, semesters, trimesters) in the curriculum. That is, we have to synchronize the related subjects of a term. So the significance of using the rank functions is to direct our attention to the need of synchronization. By the way, the rank functions may be used to sequence the elements of the curriculum. We can enumerate the elements as members of linear orderings.

To determine the cliques of a graph we use the algorithm of Warshall[7]. The algoritm calculates the connectivity matrix of the graph. The algorithm of Warshall is usable only for non-directed graphs, that is, we have to use a symmetrical adjacency matrix (the relation matrix of a directed graph would be antisymmetrical). The connectivity matrix of a graph visually shows the connected pieces of the graph, the quadratic submatrices containing only 1 values. One of the typical problems of arranging the subject matter is to determine the appropriate clustering of knowledge. Of course, these clusters may be chapters of a subject, or may be subjects in a macro modul in a modular curriculum of higher education. Cliquing is a new element in curriculum analysis [5].

The weak point using graph methods in curriculum analysis is the construction of the relation matrix. When we are inserting data in the relation matrix, we are using estimations of subject matter experts. If more experts are agreed with themselves in giving the relations, then the estimation is more reliable (that is, the experts are consistent). Our purpose is to use as reliable estimations as it is possible.

We have proposed a method to quantificate the agreement of experts. [5] The agreement of experts can be measured by Kendall's rank concordancy coefficient[8]. Of course, a concrete value of the concordancy coefficient may be influenced by random events, so we have to do a test of significance. The result of the test of significance may be statistically evaluated. The estimation of experts is usable, if the deviation of the value of rank concordancy coefficient from zero is significant[9]. General purpose statistical products can be used to calculate the rank concordancy coefficient and to evaluate its significance. However, there is a lot of manual preparative work with the preferency matrices. In the future we plan to develop a software to handle the preferency matrices and to do the necessary calculations.

4 Computer based curriculum development

An important task to build new curricula is the generation of curriculum tables. In the early eighties we had developed a mainframe based software for curriculum design. It had been written in FORTRAN[10]. This software used combinatorial and graph algorithms to generate curriculum tables for the traditional

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fixed system of Hungarian higher education. The linear orderings generated from the rank functions were used to calculate the possible curriculum tables with the backtrack algorithm. The use of this software needed computer programming expertise, so it was not applicable for a broad range of potential users. We had to wait for the advent of graphical user interface to build a user friendly software for curriculum design.

The introduction of credit point system in Hungary has involved significant changes in curriculum design. The former, fixed, obligatory curriculum tables were substituted with recommended curriculum tables. In the time of introduction of Hungarian credit point system we have examined the possibilities of computer based curriculum design. Preparing the new curricula we have found, that these possibilities are: curriculum development, course development, individual curriculum (study) development and starting of a new field of study [6].

The first possibility of computer based curriculum design is curriculum development. The credit point system needs computer based methods to generate recommended curriculum tables. This recommended curriculum table has two roles: it helps students to compose their individual curricula, and it demonstrates to curriculum users the existence of a curriculum, which is adequate with all constraints (prerequisites, corequisites, etc).

When we are computing the place of any subject in the curriculum, we have to consider a lot of conditions. Some of these are the following: the logical connections of subjects, the recommended number of contact hours per student per week (e.g. 25 hours) and the average number of credit points per student per semester (e.g. 30 credit points). A further important condition is that, if a subject has more semester-long parts, then these parts will be positioned closely in order on following semesters.

Because there is no optimal solution to the generation of curriculum tables, we have to seek possible solutions. The possible solutions can be generated using the backtracking general enumeration technique We have proposed the backtrack algorithm to compute the recommended place of the subjects in the curriculum [6].

If we want to evaluate the recommended curriculum tables, we can consider the following criteria:

- The weekly number of contact hours of students has to be balanced, if it is possible.
- The base subjects have to be taught in the same semesters together for the different groups of students to better utilize the instructional capacity.
- The number of logical connections of the subjects within the same semester has to be minimal (to reduce the problem of synchronisation).

In 2000 a curriculum and course design software was developed under our guidance as a diploma project. We shall describe this tool in the next section.

5 Computer based course development

The second possibility of computer based curriculum design is course development. In consequence of periodical curriculum reforms course development needs continuous effort. Meeting the content requirements, using the standard formats causes a lot of problems. However, because of the process of accreditation the colleagues have to use printed patterns or software tools.

Using a text processor software there is a possibility to create template files for course development. These template files can help to comply with the format requirements, but it does not solve the problem of content. In Hungarian higher education the week point of course plans is the formulation of goals, objectives and demands of individual courses. Instructors have not to get a pedagogical certificate, so they often look course development as a necessary evil. The lack of scientific pedagogical knowledge often leads to empirical solutions. To meet the format and content requirements there is a need to use a computer based system for course design. This software has to give context sensitive help for instructors, both for novices and for experts.

There is an appropriate software developed in the U.S.A., IPSI Suite [7], which is well usable for the purposes of American higher education. The software is based on the theory of D. E. Vogler about performance instruction [8]. The program defines the institutional credit policy and integrates course building, lesson building and exam building. The use of taxonomies gives the possibility of integration, measurable objectives can be used to create exams.

In Hungarian higher education there is no prescription neither to use taxonomies in pedagogical planning, nor to create lesson plans, the regulation is liberal. That is, we needed to develop a software tool for our own needs.

This tool was developed under our guidance as a diploma project in 2000. The curriculum design software permits to define the institutional credit policy, generates recommended curriculum tables from the data, and offers a template to create course plans. The course plans are exportable to a word processor software (Microsoft Word) for printing or archieving in a widely used format. The recommended curriculum table is generated using the backtrack algorithm. The starting sequence of subjects is a linear ordering calculated from the selected rank function of the curriculum graph. The linear ordering can be modified manually using the drag and drop technique. The number of contact hours per week is not considered in the calculation, because visiting lectures is not obligatory for students according to our liberal rules of study. Generating curriculum tables we can give a maximum 3 credit points range of deviation from the desired average number of credit points per semester (e.g. 30 credit points), if otherwise there is not a possible solution. The recommended curriculum table is exportable to a speadsheet software (Microsoft Excel) for printing or archieving in a widely used format. The software has a user-friendly, Microsoft Windows 9x based interface, it was written in Microsoft Visual Basic[11].

6 Computer based individual curriculum (study) planning

The third possibility of computer based curriculum design is individual curriculum (study) planning. Students need help to organize their efforts to get the prescribed credit points per semester, and to be informed about the recent state of the collected credit points.

The credit point system permits students to assemble their own study plan according to their own individual demands. Before beginning a semester students prepare a preliminary plan of study, and present it for an assent. The preliminary plan of study becomes final after the assent.

The individual departments can measure the real demands for their offered courses on the basis of the preliminary plans of students Departments can point out on the basis of demands, that they have or have not the minimal number of students to start a course, or rather where there is a need to rank students because of the over-demand.

Departments can assign on the base of demands the actually starting courses. Students can prepare their final plans of study on the base of actually offered courses, if they have to modify their preliminary plans of study because of any reason.

According to our experiences students do not build their individual study plans on the base of the recommended curriculum tables. Students take utilitarian standpoints for short distances into account selecting the individual courses. Their starting point is to reach the necessary number of credit points per semester (e-g. 30 credit points) with minimal efforts. They are rolling further the more difficult, not yet completed courses, risking that they will be canceled because of it in a later semester.

According to our experiences liberalism has harmful consequences to students in the case of curricula based on the credit point system. If the curriculum has only a minimal number of prerequisites, then the students after the first failures tend to find in advance the apparently easier way. Only thoroughly considerated prerequisites and corequisites can assure that students take in time the courses determinant from the point of view of training.

Besides the accurately planned prerequisites and corequisites there is a need to develop a computer program, which helps students to prepare their individual plans of study. This program has to contain useful informations about the recommended curriculum tables and about all courses. The students could ask information about the completed courses and the credit points collected in the individual semesters, The students could select courses using this software on the campus or at home, using an Internet connection. That is, this software has to be an Internet/Intranet application.

This tool was developed under our guidance as a diploma project in 2001. This program is based on such mature products, which are on the Unix base presented, but in the meantime to the Windows platform transplanted as the MySQL relational data base management sytem and the Apache Web server. Because of our negative experiences concerning the preliminary selection of subjects the software handles only the final selections[12].

[11]Varga, K.: Az oktatás tervezését segítő programcsomag, diplomamunka, SZIF, Győr, 2000.

[12]Hatwágner F.: A hallgatói egyéni tanrend készítését segítő programcsomag összeállítása, diplomamunka, SZIF, Győr, 2001.

Of course, this tool solves only the problem of individual planning of studies. As we know, there are plans of the Hungarian government to establish a unified data base management system of students in higher education. This software could have to solve the problem of individual planning of studies too. One of the possible candidates is the Neptun software.

7 Computer based starting of a new field of study

The fourth possibility of computer based curriculum design is the starting of a new field of study. Because of the normative sponsoring of Hungarian higher education the fundamental interest of all colleges is to increase the number of students. This is limited by the existing infrastructure and curricula. If we suppose, that the infrastructural conditions are given, then enlarging the number of students can be done by starting new fields of study accreditated by other institutions. or establishing new, not yet accreditated fields of study.

Since the process of accreditation of starting a new (elsewhere existing) field of study is simpler, than establishing a new (nowhere existing) field of study, colleges prefer to start new fields of study. This needs to coordinate the qualification requirements of the government with the existing courses of the college to point out, which new courses are to be planned.

To start new fields of study colleges need instructors too. So colleges have to take into account what kind of course plans are in disposal in the existing curricula. Existing courses usually have their full-time instructors. The existence of full-time instructors is an important condition in the process of accreditation of the new field of study. A new field of study can not be based only on part-time instructors.

These course plans have to be compared with the qualification requirements concerning the new, but elsewhere existing field of study. This comparison is not a simple task, because in some of the qualification requirements the courses are not specified, only the prescribed fields of sciences are denominated.

To solve the problem there is a need to develop a computer program. The planned program would use two data bases. One of the data bases would have to contain the qualification requirements of all existing fields of study. This data base would be built using the up-to-date CD-ROM edition of the current Hungarian legislation. The other data base would be the curriculum data base of the college, it would have to contain each of the existing course plans of the college. The curriculum data base of our college now contains about 800 course plans. It means, that we have to handle an enormous data base.

The planned software has to be capable to collect the fields of sciences and courses belonging to the selected field of study, and has to be capable to display, what existing courses of the college could be connected to the prescribed fields of science or courses. Here we have to make a practical remark: according to our experiences the same or similar course names may cover essentially different contents. That is, starting a new field of study needs human expertise.

The planned program has to ensure a keyword based search in both data base. The keyword can be a name of a field of study of higher education, a name of a course of higher education or a field of sciences. Because there may be a lot of variations in the denominations, there is necessary to build a possibility to refine search.

The search in the data base of the qualification requirements has to generate the list of the prescribed subjects and/or fields of sciences. We have to search the curriculum data base by the keywords found in the before mentioned list. The design problem needs human expertise, so there is a need to develop an interactive software. This is in our plans for the near future.

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