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INTEGRATION AND SYNTHESIS IN TEACHING SPREADSHEET PROCESSING TO INFORMATION TECHNOLOGY TEACHERS

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Abstract. This paper presents the syllabus of the Spreadsheets module developed from both an intradisciplinary and interdisciplinary perspective and used in training pre-service and in-service teachers on Bachelor and Master programs at the Faculty of Mathematics and Informatics of Plovdiv University “Paisii Hilendarski” in teaching Information Technology at school level. It was found that integration, both vertical and horizontal, facilitates the transfer of learners’ knowledge and skills to use in new, different situations.

Key words: spreadsheets, spreadsheet calculations, data processing
Mathematics Subject Classification 2000: 97B40, 97D40, 97U70

1. Introduction

In the academic year of 2006/2007 primary school teachers faced a new challenge: the introduction of the new subject of Information Technologies (IT) to the fifth grade, pursuant to a newly elaborated strategy for introduction of Information and Communication Technologies to Bulgarian schools [10]. That was necessary in order to implement the transition to an information society in compliance with the documents adopted by the European Commission. Building such a society based on a wide application of information and communication

technologies in all walks of life, can be made possible by „disseminating knowledge by means of a high-quality education system" [13, p. 32]. To that end, it is necessary to make efforts to boost the general standards of education of „the crucial asset, the human capital" in order to reach a high quality at all levels [13, p. 36]. The human capital is not just the learners at all education levels, but also the trainers – teachers and instructors.

To support the teaching of Information Technologies, at the beginning of the academic year 2006/2007, The Ministry of Education, Youth, and Science (MEYS) funded the training of teachers who were to teach that subject to the students in the 5th–8th grades. The Faculty of Mathematics and Informatics (FMI) at Plovdiv University "Paisii Hilendarski" won the competition for service provision to teachers from the South-Central Region. Under an agreement with MEYS (DO1-744 of 28.09.2006), a curriculum and syllabi were elaborated, along with the methodology for teaching IT to 5th–8th grade students based on a suite of modules, complying with the State Education Standards (SES). The syllabus was developed (with the involvement of the two authors of this paper) along with the methodology for teaching the Spreadsheets module (see [6] for the Word Processing module. Sessions - both lectures and practice sessions, used paper and electronic materials [7], available for the trainees not only during the training sessions, but also throughout the year.

At the same time, since the 2005/2006 academic year, FMI has been providing training in its Master programs for teachers of Informatics and IT both at primary and secondary school levels of the Bulgarian schools. Introduction to spreadsheets is taught either as a separate subject, or in combination with other modules on the curriculum. The knowledge due to be mastered not only covers the syllabus, but also allows trainees to use spreadsheets to address various real life problems.

2. Training methodology

The content matter taught in any of the subjects, regardless of the degree of education, reflects the current development of science and technology; it is a model of the requirements as of what a member of society should know and what skills he or she should have. For M. Andreev, this is the „capacity and quality of knowledge, skills, habits and methods of cognition" [1, p. 119] which learners are supposed to acquire. This content is part of the knowledge in the relevant science domain which is processed by the teacher-pedagogue and is the object of scientific and cognitive activity by the learner; it is subjectivized and becomes „an integral part of conscience ... in the form of cognitive structures" [5, p. 27]. The content matter is

always in close relationship, in a dynamic unity with the object of training, as the teaching content has a leading role. While the teaching goal is relatively constant, the teaching content is an outcome of the development, the speed and depth of changes in science – the accelerated increase in the volume of knowledge and technologies. According to Kulyutkin „a major source of interest in a curricular activity is mostly its content" [9, p. 57] – in order to have a stimulating effect, it must meet a number of requirements formulated in the principles of teaching (scientific in nature, related to real life, systemic and consistent, with a comprehensive educational, instructive and developmental effect)."

In this respect, of significant importance are the selection and structuring of the syllabus; the balance and hierarchy of the general and specialized educational training, which leads to the division into subject areas. Systematizing knowledge, skills and habits corresponds to the differentiation in science; this is a reduction of differentiated scientific knowledge in accordance with its function in education. The accepted spiral-like distribution (vertical integration) of learning content reflects the continuity between knowledge gained at a certain degree and another, higher degree. The horizontal integration determines the connections and interrelations between the subjects and activities taught at a certain level. Integration is constructed in view of: content area knowledge, number of teaching hours, cognitive development and age specificity [2, p. 157]. Thus, the syllabus is built through a synthesis at different levels: intradisciplinary (within a subject) and interdisciplinary (between subjects). A transfer of learners' knowledge and skills takes place in different situations.

In the work covered by this paper we selected and structured the syllabus of the Spreadsheets module using the approach of integration: horizontal and vertical, as we took into consideration the intradisciplinary and interdisciplinary connections of the field of study with other modules and courses used in learners' training. Setting up a database required the input of data of certain types and layout of the structural units, and part of the design properties had been covered by the Word Processing module. Interdisciplinary connections were implemented while doing calculations, retrieving data based on various criteria (referring to mathematics and informatics).

3. Syllabus of the Spreadsheets module

The elaboration of the syllabus requires not only complying with the changes in this field of science, but also with development of those features of reasoning that allow restructuring of the existing knowledge by the trainees and transfer to a new environment. Structuring the syllabus complies with the approaches described above: integration and synthesis.

A. Basic level. Knowledge and skills trainees acquire are the minimum required to teach the Spreadsheets module during the compulsory optional classes in the schools.

Unit 1. *Spreadsheet (SS): essentials and major components: row, column, cell, worksheet; possible operations. Name, type and value of a cell, dependence between the cells*:

- a hierarchy of structural units is built and different ways of insertion, deletion, and relocation of the elements are considered;
- to insert and edit cells, we should mention: available techniques of the spreadsheet processor under consideration; possible categories of content – text, numbers in various formats, data such as date and hour;
- in formatting emphasis is placed on: sequence of characters, justification (horizontal and vertical), borders and fill color for a range of cells; dimensions and visibility of rows and columns; worksheet properties.

Studying this unit involves knowledge and skills on: working in the environment of the relevant operating system (in editing data), formatting properties of characters and paragraphs (cell content is considered one paragraph), some of which have been covered in the Word Processing module.

Unit 2. *Designing and developing a table. Spreadsheet calculations: elaborating formulas, applying embedded functions*:

- focus is oriented toward building a model for representation of the available tabular data;
- the content categories of different parts of the spreadsheet are identified;
- formulas are designed for implementing the relevant calculations and the formal parameters are set;
- in developing the spreadsheet, after entering the data and formatting of the elements, formulas are entered as the formal parameters are replaced with actual (the names of specific cells).

Constructing formulas requires knowledge on: correct notation of expressions, comparison relations, formulation of logical operations (from Mathematics); working with formal and actual parameters (from Informatics).

Unit 3. *Addressing in spreadsheets. Types of addresses*:

- applying suitable models of tabular data, dependences between the cells are described by using relative, absolute and mixed types of cell reference.

Unit 4. *Graphic representation of spreadsheet data – charts: types, steps in development, elements, modification*:

- the main types and varieties of charts and their intended use are considered as emphasis is placed on the proper choice of data series;

- designing the chart: choosing the type and variety, identifying the data series and their location, setting details in using data from different spreadsheets; additional preferences are set concerning axis title, value visualization, chart alignment.

Unit 5. *Printing tables and charts: settings, printing areas*:

- printing areas are set – all elements from one or several worksheets, the information from all worksheets, selection from a worksheet, chart;
- setting page properties – size, orientation, borders, scaling in percentage of the normal size;
- additional settings: including rows and columns which will appear at the top and on the left of each printed page (for big spreadsheets); print quality and sequence;
- setting headers and footers (separately for each worksheet).

B. Additional options. The acquisition of knowledge and skills in the field of the topics covered in this part allows learners to use spreadsheets in solving real-world problems, to teach specialized classes and voluntary optional classes.

Unit 6. *Working with workbooks: creating and editing templates*:

- designing the template (identifying the cell allowing data entry by the user);
- setting a spreadsheet model and locking the spreadsheet; saving the file as a template;

Unit 7. *Working with fields: the naming of data fields and their use in formulas, search and reference functions*:

- considering the possibilities to create descriptive names for easy reading of cells, fields and formulas; setting 3-D references (names representing the same field from several worksheets); converting row and column headers into names; using named fields;
- retrieving data from the already created tables in other worksheets or file documents to form new tables.

Unit 8. *Data summary and data control. Sorting. Defining and using filters. Organizing intermediate calculations in lists and fields*:

- clarifying data control when data of different types is entered;
- presenting two types of sorting: natural order (lexicographical) or by custom list, as well as sorting on more than one criterion;
- emphasizing the ability to filter data according to set criteria using links of the type “and” and “or”;
- in cases of suitable grouping of repeating values in a field, calculations are made both for the separate group and for the whole table.

Mastering the technique for implementing intermediate calculations requires first the acquisition of skills for sorting on one or more criteria, knowing and using embedded functions – thus implementing an intradisciplinary connection.

The proposed syllabus was implemented through lecture materials for presentations on an LCD projector [8] and a set of exercises for hands-on sessions, both developed by the second author of this work. The spreadsheet processor Excel from the Office suite by Microsoft Corp. was used for the acquisition of skills and habits [3]. The assessment of the acquired practical skills was conducted through the performance on individual tasks requiring the use of a spreadsheet processor. A didactic test was used for measuring the outcomes of the learning activities in terms of theoretical knowledge and that was the major measuring tool for the level of attainment of knowledge and skills at a certain level. The test administration was done with appropriate tools using an automated testing system which allows creating static and dynamic test questions, manual and automatic test generation, conducting group examination and assessment [12] [11].

4. Conclusion

Society is in a period of transformation; priority is given to implementing an intelligent, sustainable and inclusive growth to meet the objectives set out in [4, p. 3-4]. Intelligent growth means improving knowledge, quality of education, by making the maximum use of information and communication technologies, i.e. trained personnel are needed. The skills trainees develop for working with spreadsheets, based on integration and synthesis of knowledge, not only enhance their professional qualification, but also allow transfer of this knowledge to other fields, e.g. working with databases and developing information systems. This is related not only to training and education at a certain level, but also throughout their lives, by emphasizing the outcomes of education – “indicators of what a learner knows, understands and can do upon completion of the learning process, which are defined in terms of knowledge, skills and competences" [14, p. 11].

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ИНТЕГРАЦИЯ И СИНТЕЗ В РАБОТАТА С ТАБЛИЧНО ПРЕДСТАВЕНИ ДАННИ ПРИ ПОДГОТОВКА НА УЧИТЕЛИ ПО ИНФОРМАЦИОННИ ТЕХНОЛОГИИ

Евгения Ангелова, Татяна Дичева

Резюме. В настоящата работа, на базата на синтез на различни нива: интрадисциплинно и интердисциплинно, се представя учебното съдържание за модул „Електронни таблици”, по което се извършва подготовката на студенти и учители в бакалавърска и магистърски програми във ФМИ на ПУ „П. Хилендарски” за преподаване на информационни технологии в училище. Интеграцията (вертикална и хоризонтална) улеснява преноса на знанията и уменията на учащите за прилагането им в нови и различни ситуации.