Competencies and Contents Specific to ICT Disciplines from Romanian High School Education

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1. High School Education System in Romania

Upper secondary education covers:

- High School – *Liceu/Colegiu* (15-19/20 years of age)
  - Academic (Theoretical) – 4 years (Specialization: Mathematics and Computer Science; Natural Sciences; Social Sciences; Philology);
  - Technological (Specialized) – 4-5 years (Profiles: Technical, Natural Resources and Environment Protection, Services (Economic/Business). For every profile exists some specializations, e.g. for Technical profile: Telecommunication, Electronics and Automation, Electrotechnics; Mechanics; Civilian Building etc.
  - Specialized Vocational (Aptitude based) – 4-5 years (Profiles: Sports, Arts and Music, Military, Theological, Pedagogical).
- Vocational (training) Schools – *Scoala Profesionala* (Vocational Upper Secondary – 15-19 years of age);
- Apprenticeship Schools – *Scoala de ucenici* (15-18 years of age).

Admissions criteria: the compulsory education leaving certificate (*certificat de capacitate*) is required by all establishments, except apprenticeship schools. All the schools organize entrance examinations. Only medical post-secondary schools require the baccalaureate diploma. The other admission criteria for post-secondary level are the same as for upper secondary education.

1.1. Structure

High schools are mostly public, but a small number of them are private. Teaching is carried out in the Romanian language, but there are also high schools where the teaching is carried out in the languages of the ethnic minorities.

Upper secondary education is organized as follows: day classes over a four-year period (year 9 to 12) and evening classes or extra-mural classes over a five-year period (year 9 to 13). The latter are designed for those who, are involved in other activities in addition to the school programmer. Public upper secondary education is free. Pupils from economically disadvantaged families do not have to pay for textbooks.

In order to be admitted to these schools, pupils apply to sit an entrance examination, after they have completed general compulsory education and obtained a leaving certificate (certificat de capacitate). Pupils can apply for the examination to again access to upper secondary schools (day classes) immediately after lower secondary school or two years thereafter. If they are more than 17 years of age, they may not attend day classes.

There are three types of high schools**: Academic (Theoretical)** – 4 years (Specialization: Mathematics and Computer Science; Natural Sciences; Social Sciences; Philology); **Technological (Specialized)** – 4-5 years (Profiles: Technical, Natural Resources and Environment Protection, Services (Economic/Business). For every profile exists some specializations, e.g. for Technical profile: Telecommunication, Electronics and Automation, Electrotechnics; Mechanics; Civilian Building etc; **Specialized Vocational (Aptitude based)** – 4-5 years (Profiles: Sports, Arts and Music, Military, Theological, Pedagogical).

All types give access to higher education and most of them also offer a qualification and therefore the opportunity to obtain a job after graduation.

The classes are mixed, and are organized according to age group. Classes on average have 25 pupils, a minimum of 15 and a maximum of 30.

Most high schools function as independent institutions. Some function together with lower secondary and primary schools, and some are integrated in combined groups of schools (technical high schools) together with vocational training schools. All high schools work two shifts: classes in the morning and classes in the afternoon.

The school programmer consists of an average of 6 hours per day and 30 hours per week, with some differences, according to the type of high school and the year of study. Pupils attend classes five days per week. Starting with 1998/1999, the school year is divided in two semesters.

1.2. Curriculum

High Schools can design their own plans on the basis of the Educational Plan for high school approved with O.M. 4634/03.08.1995. The syllabi of all subject matters have been reviewed and updated taking into account the regulations of Ministry of Education and Research.

The education plan covers five groups of subjects:

- Humanities and Social Education (Romanian language and literature, two foreign languages, world literature, history, psychology, logic, economics, philosophy and also Latin Greek, aesthetics, history of music, etc.);
- Basic Scientific Education (mathematics, physics, chemistry, geography, biology);

- Optional Subjects (examples: for a basic scientific education - laboratory techniques applied to Physics, Biology, or Chemistry, Information Science, History of Science. For humanities and social education - elements of conservation, reconstitution and museum organization, shorthand and typing, general linguistic and literary theory, elements of archaeology and paleography);
- Physical Education;
- Open Discussion (civics, health education, ecological education).

The importance of each group varies according to the profile of the secondary school, the greatest variations being at the level of humanities/social and scientific subjects. In high schools such as those for art, sports, technology or economics, for example, the optional subjects are more important and usually take up 30% of the total number of hours; these upper secondary schools also have more teaching hours per week (33 to 35 hours).

In the schools for the humanities (Philology Schools, Languages Schools, History-Social Sciences Schools), the humanities and social subjects prevail, with approximately 50 to 60% of the time, scientific education having a share of 25 to 30%.

In Science High Schools (mathematics-physics, physics-chemistry, chemistry-biology), scientific education prevails, with approximately 50% of the time, whereas education in the humanities has a share of about 30%.

In Teacher-Training High Schools, humanities and science education have a similar share - about 30% of the time. An important role (about 30%) is dedicated to specific training (methods, educational psychology, art).

In High Schools for Technology, Agriculture, Forestry, Economics etc., the humanities, science and specific training are of equal importance. In the last two years of study, attention focuses on the specific training.

For the last types of high school, the educational curriculum includes hours of specific practical activities in businesses, schools and other institutions. These activities are given greater importance in the last two years of study.

1.3. Assessment

Pupils are subject to continuous assessment with a formative character in all subjects. The assessment is mostly oral and individual, based on numerical marks from 1 to 10. For some subjects, pupils are given written assessments during the semester and at the end of the semester (final assessment). Responsibility for the assessments lies with the teachers - they decide (depending upon the knowledge acquired) if a pupil should be required to repeat a class or not. Pupils in the last two years of study are subject to tests set by the County School Inspectorates.

The right school ends with a final examination (*examen de bacalaureat*), under the aegis of a commission established by County School Inspectorates.

Article 26 of the 1995 **Education Law** established the subjects covered by the final examination:

- Romanian language and literature - written and oral;
- Language and literature of the national minorities - for pupils doing their studies of the languages of the national minorities;

- Mathematics - written; in humanities, theology, art and sports upper secondary schools, pupils can choose a humanities subject instead - written;
- Romanian history - oral;
- One of the foreign languages studied - oral;
- One optional subject – informatics, physics, chemistry, biology, Romanian geography - written;
- One optional subject, chosen by the pupil, different from the above subjects - oral.

If they obtain their leaving certificate (*diploma de bacalaureat*), pupils can apply for the entrance examination to gain admission to higher education. Candidates may participate in a final examination (*examen de bacalaureat*) no more than three times. In technological high schools (*licee tehnologice*), if they pass an examination, and a practical test and write a paper concerning a specific subject, they also obtain a certificate (*atestat profesional*) granting access to a job.

1.4. Teaching staff

In High Schools, all subjects are taught by specialist teachers, holding a diploma and having completed a long course of higher education, depending on the subjects they are teaching.

Technological education is provided by engineers, trained in Polytechnics (University of Applied Science/ Technical University) and practical training by instructors (*maistri*).

Teachers teach the same subject in several classes. Every class has a class teacher (*diriginte*) who coordinates the education activities of the class and maintains with parents.

The teacher's right to in-service training is granted by the Ministry of Education and Research, which co-ordinates and finances it. In-service training of teaching staff is provided in higher education institutions by courses in a particular field, or in methodological and psycho pedagogical training.

2. The curricular key-stages

The curricular key-stages represent schooling stages that cover several years, sometimes belonging to different school level and which share common objectives.

Age	6	7	8	9	10	11	12	13	14	15	16	17	18
Grade	Prep. year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Key stage	Basic acquisitions			Development				Observation and orientation			Reinforcement		Specialization

3. ICT in Romanian High School Education

A minimal list of qualifications necessary to teachers who use ICT in didactics activities:

a) Use of ICT instruments in order to simplify its own and student activity (text editing, spreadsheets, multimedia applications, e-mail, presentations programs).

b) Knowing the main characteristics of information

c) Use of ICT for simulation and modeling of some situations of the teaching discipline.

The usable methods in computer-assisted lessons are:

a) Methods de informing, documenting, processing and storage of information

b) Learning methods and techniques

c) Research-investigation methods and techniques.

ICT offers to students great opportunities in the direction of cooperation with colleagues, tutors, experts, professionals, parents etc.

The features of the learning through cooperation are: transfer of knowledge; modification of the student's and professors values; team forming.

The structure of the curriculums:

a) The 9^{th} grade (class) belongs to the curricular observing and orientation cycle. The curriculum for this grade (class) contains: a note of presentation, frame objectives, objectives of reference, examples of learning activities and contents.

b) For the $10 \div 12$ classes (grades), the structure of the curriculums allows the focus on the qualifications that are to be formed at students and that ensure the correlation of the learning contents to these qualifications.

The following are ensured: the forming of the didactic act on the final acquisitions of the learning; the emphasis of the "action" dimension in forming the personality of students; clear definition of the school's offering in respect to the interests and vocations of the student as well as to the expects of the society.

The curriculum to school decision mentions the following types of optional:

a) Of thorough going study;

b) Of extension;

c) As a new discipline;

d) Integrated to the level of one or more curricular areas;

e) As a discipline that appears in the common block at other specializations.

COMPUTER SCIENCE

ALTERNATIVE 1 **the 9th grade**

The learning unit	Contents	No. hours	Week.	Notes.
1.Arhitecture of computing systems	• Structure and functions of a computing system • Health and safety when working with computers • Operating Systems (functions, characteristics)	4	1-4	(1 hour/week in parallel with 3)
2.Using computing systems	• Operating Systems (interface elements) • Computer assisted programs • Text editor; image editor; applications	12	5-16	(1 hour/week in parallel with 3,4)
3.Algorihtms	• The concept of algorithms; characteristics • The elements and the stages of resolving a problem • Representation of algorithms • The principles of structured programming; applications	10	1-10	(1 hour/week in parallel with 1,2)
4.Programs	• Programming languages (base concepts) • The structure of programs; control structures • Data (simple types, variables, constants, expressions) • The environment of the studied programming language • Implementation of algorithms (exercises)	10	11-16 17-18	(1 hour/week in parallel with 2) (2 hours/week.)
5.Data structure	• Tables (charts) • Character strings • Recordings • Text files	12	19-24	
6.The building of an application	• Stages in the development of an application • Requirements for developing programs	12	25-30	

ALTERNATIVE 2 **the 9th grade**

The learning unit	Contents	No hours	Week	Notes
1.Algorithms	• The notion of algorithms, characteristics	10	1-5	

	• The elements and stages of resolving a problem • The objects with which the algorithms work • The representation of algorithms • The principles of structured programming; applications (exercises)			
2.The architecture of the computing systems	• The structure and functions of a computing system • Health and safety when working with computers • The history and evolution of computing systems	4	6-7	
3. Using computers	• Operating Systems (functions, characteristics, interfaces) • Shells (Norton Commander, Explorer)	6	8-10	
4.Using computers	• Text editors • Image editor • Utilities	8	11-14	
5. Programming languages	• Programming notions (basic notions) • The structure of programs; control structures • Data (simple types, variables, constants, expressions) • The environment of the studied programming language • The implementations of algorithms (applications)	10	15-19	
6.Structuri de date	• Table, character strings, records • Text files	12	20-25	
7.The building of an application	• Stages in the development of an application • Requirements in the development of programs • Applications made by groups of students	10	26-30	

ALTERNATIVE 1 **the 10th grade**

The learning unit	Contents	No hours	Week	Notes
1.Subprogrames (routines)	• Recapitulation (types of data, data structures) • The structure of subprograms	18	1-6	

	• Declaration and call-up (transfer of parameters, local and global variables, return) • Applications (user-defined, predefined subprograms, libraries of subprograms)			
2. Data structures	• Data structures (definition, classifications) • Dynamical structures: the list, the queue, the stack (pile). • Specific operations (creation, addition, elimination, browsing, testing) • Applications	12	7-10	
3. Recursion	• General presentation • The mechanisms of recursion • Applications	12	11-14	
4. The *BACKTRACKING* method	• Non-recursive Backtracking (presentation) • Applications • Recursive Backtracking • Applications	24	15-22	
5. The *DIVIDE ET IMPERA* method	• General presentation • Applications	12	23-25	
6. Designing applications	• Stages in developing an application • Technical characteristics of applications • Project-like applications designed by groups of students	15	26-30	

ALTERNATIVE 2 **the 10th grade**

The learning unit	Contents	No. hours	Week.	Notes
1. Data structures	• Recapitulation (the elements of the language, types of data) • Data structures (concepts, classification) • Static structures (recapitulation) • List, queue, stack-type structures; specific operations	12	1-4	
2. Modularizing and parameterization	• Subprograms (definition, classifications, call-up) • Parameters (types, transmission) • Global/Locale variables	18	5-10	

	(visibility, life-time) • Applications using data structures • Predefined subprograms and *libraries of subprograms*			
3. Recursion	• Exemplification through intuitive methods • General presentation • The mechanism of recursion (call-up and return) • Applications with recursive subprograms • The DIVIDE ET IMPERA method (presentation) • Binary search algorithm • The sorting algorithm (through collation or quick-sort)	21	11-17	
4. *BACKTRACKING*	• Presentation of an illustrative example • General presentation of the method • Combinatorial generation applications • Recursive handling of the method	24	18-25	
5. Designing applications	• Stages (analysis, concoție, implementation, presentation) • Elaboration of documentation • Characteristics of a program-product	15	26-30	

ALTERNATIVE 1 **the 11th grade**

The learning unit	Contents	No. hours	Week.	Notes
1. Dynamic allocation	• The reference type, pointers • Dynamical variables • Operations (allocation, accessing, release) • Dynamically allocated linear structures (lists; specific ops)	28	1-7	
2.Graphs	• Un-oriented graphs (definitions, representation) • Browsing of un-oriented graphs • Connectivity; connected components • Oriented graphs (specific	28	8-14	

	definitions, representation) • Tere conexitate			
3. Trees	• Definitions, classifications, representation • Representation in memory (static and dynamic) • Browsing • Binary search trees • Partial tree of minimum cost	24	15-20	
4. Object oriented programming	• Basic concepts • Encapsulation • Inheritance and polymorphism • Applications	20	21-25	
5. Designing applications	• Elaboration of a project with graphs / dynamic allocation • Development of interface elements with self or predefined objects	20	26-30	

ALTERNATIVE 2 **the 11th grade**

The learning unit	Contents	No. hours	Week	Notes
1. Graphs	• Un-oriented graphs (definitions, representation) • Browsing un-oriented graphs • Connectivity; connected components • Oriented graphs (specific definitions, representation) • Tere conexitate	20	1-10	(2 hours/week in parallel with 3)
2. Trees	• Definitions, classifications, representation • Browsing (generalities, browsing binary trees) • Binary search trees • Partial tree of minimum cost	20	11-20	(2 hours/week in parallel with 3)
3. Dynamic allocation	• Reference variables, the pointer type • Dynamic variables • Operations (allocation, accessing, release) • Dynamically allocated linear structures (lists; specific ops.) • Applications, with lists, graphs, trees	40	1-20	(2 hours/week in parallel with 1,2)
4. Object Oriented Programming	• Basic concepts • Encapsulation, inheritance, polymorphism	24	21-26	

	• Applications			
5. Designing applications	• Elaboration of a project with graphs / dynamic allocation • Development of interface elements with self or predefined objects	20	27-31	

4. Conclusions

In the field of teachers training , the Minister's Order no 3437/18.03.1998 has approved "The In-Service Teacher Training Programme in pre-university education" which contains a series of training sessions in using computers for the teachers teaching in pre-university education. Through the Minister's Order no 3345/25.02.1999 concerning initial teacher training, of training a specialist for the teaching career, there are a few recommendations that encourage the adaptation of the curriculum used in universities and colleges that train future teachers to the new orientations of primary and secondary education: training future teachers to use modern technologies.

The training in the field of the use of Information and Communications Technologies has to be extended to all the categories of citizens and all age groups. This objective is closely linked to the professional re-training and lifelong education. Through MO 3354/25.02.1999, the Ministry of National Education has approved the setting up of "Open and Distance Learning" which can be organised by any universities trough general courses, professional re-training courses, or revising professional knowledge, courses and seminars that have a curriculum that leads to obtaining a Degree, or post-graduate courses.

AEL e-learning platform is an integrated teaching/learning program and content management system, based on modern educational principles and technologies. The AEL e-Learning platform offers support for teaching and learning, for tests and evaluations, for managing the educational content, for monitoring the educational system and creating the curricula. AEL can be used for the learning process assisted by the teacher/trainer or for individual education. AEL is implemented at undergraduate and graduate levels of the educational system, as well as in corporations, for internal employee training.

5. References

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