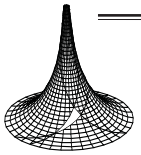


INFODIDACT (2008), 3–24
tmcs@inf.unideb.hu
http://tmcs.math.klte.hu

Teaching
Mathematics and
Computer Science

ICT methodology

László Zsakó, Katalin Juhász and Zoltán Kátai

Abstract. This article is an overview discussing what ICT subject methodology, ICT didactics and ICT methodology are, what the philosophy of ICT is, and finally what ICT pedagogy is.

Key words and phrases: didactics, methodology, informatics.

ZDM Subject Classification: P80, Q10, R00.

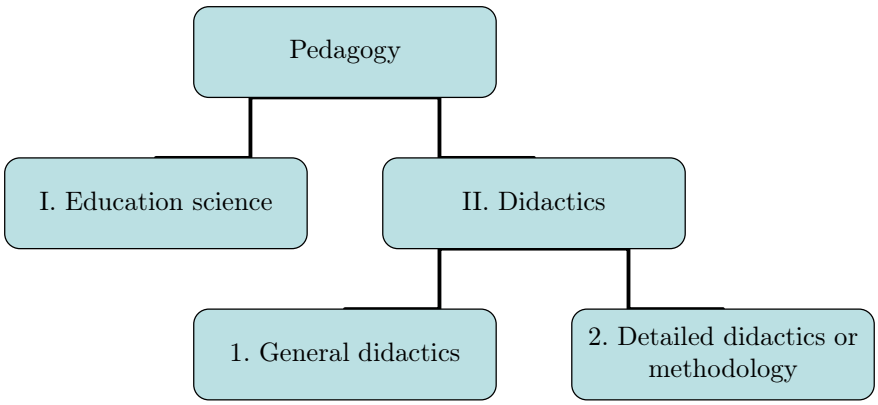
Introduction

A short mention should be made of the background of defining methodology. We would not like to go into details regarding the literature of this field of pedagogy or the battle of words on names within pedagogy. We would just like to give a really short overview.

For a long time the didactics of school subjects were not considered an independent field of science but just a "maid-servant" of pedagogy. Here comes a quotation from the encyclopaedia of pedagogy [1]:

> *Methodology (or methodics) is a very practical branch of pedagogy that is compartmentalized even according to school types. It applies universal principles to individual subjects that appear in any education; (. . .) it means applied detailed didactics. (. . .) It is of great use for teachers and instructors who are at the beginning of their carrier because it enables them to make use of the experience and contemplations of excellent practising educationalists. . .*

This definition might result in the idea that methodology could at the most be an applied science of pedagogy. Ödön Weszely [2]—following Herbart, the great "classical"—includes didactics in the family tree of related sciences as follows:



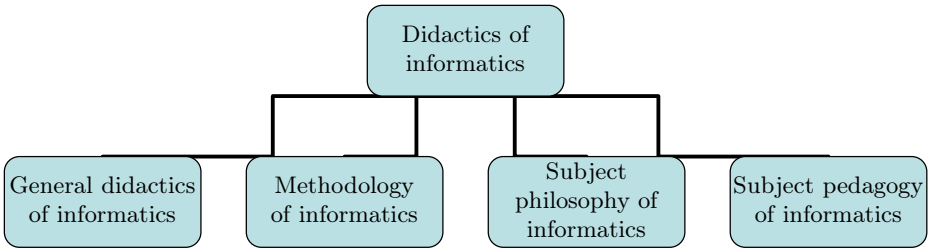
The essence of Weszely's detailed train of thought is that the part of teaching the subjects of teaching is methodology or the detailed science of teaching "... which deals with teaching methods of every subject separately and in a detailed way, and doing so, it offers principles that are valid for teaching that single subject, and therefore they are not general but detailed."

It is a kind restriction, because according to this idea the only task of this field of science is to study and describe teaching methods.

The word methodology also poses a slight problem, as it can be used in two senses. One is the methodology of scientific research, whereas the other one is the methodology of studying and systematizing the methods applied in certain task areas. In the English speaking world, for example, there is "subject methodology" and "research methodology".

Relying on the above, one could raise the question: what is didactics and what is methodology? Are they the same or are they different?

The above figure can be rephrased, and the decomposition principle of part II can be applied to II. 2, which could then be called subject methodology. According to the figure, it might consist of general questions of teaching a subject (let us call it subject didactics), and detailed questions of teaching a subject (let us call it subject methodology). In addition to the above, there is subject philosophy (which is about the grounds of a subject, and subject pedagogy (which deals with the special pedagogical aspects of teaching the subject).



This categorization cannot always be used for organizing the subject methodology curricula of school subjects, but it is consequent in its kind and contains everything that one might need to learn how to teach ICT well.

A similar idea is formed on the methodology of history in an article [3]:

> *Finishing our etymological argumentation, we can state together with Pál Bakonyi that although we do not believe in pow-wow, "... words direct our thoughts to a certain extent. Methodology directs us towards methods and teaching, whereas subject pedagogy towards pedagogy! ... Inconsistency in terminology, unfortunately, reveals the inner uncertainty of our profession". The names methodology, subject methodology only stimulate us to elaborate methods in a narrower sense and method variants, subject didactics refers to the full subject scope of educational questions, whereas subject pedagogy touches upon the total scope of possibilities of teaching and educating through a subject i.e. it is the only one that can be interpreted from the point of view of our pedagogy that develops the whole personality of the student.*

In order to define the concept and contents of general didactics of informatics it is worth studying one of the most related fields, i.e. the general didactics of mathematics. According to Z. Krygowska [4]:

> *As a branch of science, general didactics of mathematics is in the first phase of its evolution: it slowly and gradually develops its own methodology and language. Although there are several publications on the theoretical and practical results of this field, we are far from scientifically well-grounded generalisations, deeper theoretical comprehension and interpretation, and we have not exceeded the phase of local organization and structurization concerning teaching and learning mathematics. General didactics of mathematics is a discipline being born (in statu nascendi), which must be admitted without grudge and fear of favour even by those that deny the scientific nature of this discipline. However, those that*

want to consider it a well-defined branch of science are wrong, as well. The realization of the pioneer nature of the research in general didactics of mathematics is also essential for those that are engaged in this science because it will protect them from the premature absolutization of those theorems of theirs that lack sound theoretical and empirical grounds.

The beginnings of general didactics of mathematics go back in time as far as the early 1960s. The general didactics of informatics is an even younger "branch of science"; its foundations were laid perhaps in the early 1980s.

Éva Vásárhelyi [5] writes about independence compared to pedagogy. Regarding subject didactics, she claims the following:

Subject didactics research can be interpreted and perceived in the full system of a given branch of science, and usually requires special knowledge and experience in the given field. To clarify its relationship to the branch of science is also important for teacher training. ... On the other hand, it is known that subject didactics could give various answers to a certain question (just like the social sciences in general, the methods and results of which it uses). ... Interdisciplinary is a basic characteristic feature of subject didactics and at the same time it is an essential distinctive feature that tells it apart from special scientific research.

We would like to quote Éva Vásárhelyi [5] regarding the difference between subject didactics and methodology although she wrote it with a different aim in mind:

Subject didactics research cannot be restricted to a unique situation or detail of teaching the subject, but must be extended to students' age-related idiosyncrasies, the contents of the subject, its relation to expected learning outcomes, the type of school, as well as to the special teaching and learning objectives.

Bearing in mind the above, instead of extension we promote distinction as this is the way how subject didactics and subject methodology can be parted.

General didactics of ICT (draft)

Now the question of didactics "What, why, with what and how?" can be rephrased for the general didactics of ICT; it can be determined what topics it must contain:

1. Structure and contents

A) What should a teacher teach?

B) What shold a student learn?

C) What are students expected to acquire?

D) What type of knowledge are students expected to acquire?

E) Does evaluation influence the teaching-learning process and the curriculum?

2. Objectives, skills and abilities

A) Curriculum philosophy, approach?

B) Why should a teacher teach something?

C) Why should a student learn something?

D) Why is a student expected to learn no other but that particular thing?

3. Teaching methods

A) How should a teacher teach?

B) How should a student learn?

C) How to evaluate?

D) How should a teacher learn?

4. Tools

A) What should a teacher use for teaching?

B) What should a student use for learning?

C) What should be used for evaluation?

D) Does the tool affect thinking?

5. Relationship between the participants of the learning process

A) Teacher—student?

B) Teacher—course-book?

C) Student—course-book?

D) Teacher—electronic curriculum?

E) Student—electronic curriculum?

F) Course-book—electronic curriculum?

6. The relationship between learning and education

A) The possibilities of team work?

B) The possibilities of project work?

C) The participation of talented students in the teaching-learning process on the side of the teacher?

D) What are the possibilities of talent management?

7. Efficiency and effectiveness

A) Why should the teacher teach this way?

B) Why should the student learn this way?

C) Why should we evaluate this way?

D) What method can be used to measure efficiency?

8. Other

A) What special parts of non-ICT fields of knowledge should an ICT teacher teach?

B) What special parts of ICT fields of knowledge should a non-ICT teacher teach?

General didactics of informatics (explanation)

1. Structure and contents

A) The concept, structure, topics of ICT and how they are structured and built on one another.

B) The "definition" of ICT, the "definition" of ICT as a school subject

C) The objectives of ICT education, ICT competences (algorithmic thinking, users' approach, complex problem solving, intelligent communication, training to independent work, to team work and cooperation, to creative work, orientation in the information society)

D) The definition of ICT topics:

a. algorithmization, data modelling;

b. the tools of program-making (algorithm-describing tools, programming languages, program developing and testing environments);

c. solving application tasks (drawing, word processing, desktop publishing, spreadsheets, database-management, image editing, presentation, animation and video editing, multimedia);

d. handling application systems;

e. complex problem solving, individual and team work, ICT-aided projects;

f. infocommunication (man-to-man communication with intelligent tools—mailing, mailing lists, forums, chat, video-phoning, video conferencing; man-to-computer communication—webpage-design, navigating, searching, GIS applications);

g. media informatics (the informatization of texts, music and TV films; portals, interactive-digital TV and radio);

h. using ICT tools (hardware, software, network, utilities, common elements of developing tools and application system-developing tools—e.g. loading, saving, printer set-up, etc.);

i. information society (history of the past, present and future, the opportunities of the information society, legal, ethical, psychological and security questions and problems, etc.).

E) The structuredness of ICT topics (parallels are also possible).

It is worth considering whether the following topics belong to the field of ICT or not: the structure and function of ICT tools, (or does it belong to design and technology?), number representation and numeral systems (or do they belong to mathematics?), mathematical application systems (or do they belong to mathematics?), information storage (or does it belong to physics?), mathematics necessary for ICT (what mathematics does not teach, or it teaches in a different way and at a different time and not when and how ICT needs it)?

ICT topics assigned to age groups (when, to whom, what?).

Basically, two guide-lines can be followed when assigning certain ICT topics to certain age groups:

A) Given topics is taught when students have reached an intellectual level or have enough background information that enables them to fully acquire it.

B) The topic is broken down to difficulty levels. We strive at introducing the topics as soon as possible—at a basic level with methods adequate to the age group—, then later they will be deepened and expanded.

The organisation of the material of the topics according to age groups, through realistic examples understandable for the given age group.

The organisation of ICT as a school subject.

Linear and cyclic (spiral) curricula, arguments for a choice, the principles of the organisation of the subject:

A) *The principle of relating to previous knowledge*: when teaching a topic it is necessary to refer to lower levels of that topic and in addition to rely on the students' out-of-school experience.

B) *The principle of continuation*: a certain topic should not be included ad hoc at a given part of the curriculum, but in such a way that at a higher level one could rely on the knowledge previously acquired.

C) *The principle of learning with anticipation*: teaching a certain topic should not be postponed until higher classes, when a final and closed processing is possible, but it has to be introduced earlier in a simple way.

D) *The principle of simplification*: the teacher should facilitate students' work, he/she should make the material to be learnt comprehensible for them with simple introductory methods, without derogating the essence of ICT. When applying this principle, the teacher—when designing the curriculum—should pay careful attention to the fact that the simpler introductory methods might have by-products that need re-evaluation at a later phase (but it is important that they should not be confuted).

E) *The principle of integration*: it claims that in education it is necessary to emphasize mental connections between items of knowledge, and one must strive to build a network of these relations.

F) *The principle of stabilisation*: in order to make a pattern or a concept become a stable part of the students' cognitive structure, it is necessary that from time to time they practise and apply them in new contexts, and this way they will become general, discriminated and connected to other patterns, as well.

The practical continuous length of teaching certain fields of knowledge (2–3 months, 1–2 weeks, 1 hour, 10 minutes, outside the traditional class).

The subject structure originating from the length of teaching and the time limit (the approx. biennial recurrence of possible topics with the distribution of shorter topics between big blocks).

Content regulation (National Curriculum i.e. NAT, framework curricula, requirements of the school-leaving exam, etc.).

Hungarian regulations, regulations in other countries, their comparison, arguments for and against.

The question of the minimally common curriculum, its formulation.

The relationship between the NAT and the requirements of the school-leaving exam.

Preparing local curricula based on the NAT, or some other framework curriculum.

How to prepare a local curriculum based on the NAT and a local curriculum based on the framework curriculum?

How is ICT related to other fields of knowledge and other school subjects, borderline areas.

Mathematics:

- The relevance and correctness of algorithms is not obvious and must be proved mathematically.
- There are mathematical problems that can be proved with the help of computer programs (A famous example for this is the "four colour theorem" of graph theory).
- A computer-aided solution of a problem often means that the mathematical proof is algorithmized.

Sciences.

Hungarian language.

Health education and life skills—design and technology.

Arts—music, visual arts, film and media studies.

ICT outside school: computer literacy—the objective and curriculum of ICT literacy.

The concept of ECDL (ICDL), its structure and testing.

The relationship between ICT NAT and ECDL (ICDL), the relationship between the school-leaving exam and ECDL (ICDL).

ICT vocational training: ICT professions.

The ICT professions, their curricula, systems of examinations.

The relationship between general ICT and vocational ICT.

What is the difference between the material to be taught and the material to be learnt? Learning without a teacher—teaching without a student.

What material is practical for the student to learn independently without teacher's help?

How and what is the teacher supposed to teach without direct relationship with students (e.g. distance learning)?

Assessment, the curriculum of feedback, what has it got to do with the material to be learnt?

- Is everything taught should be asked and tested?
- Can something be asked that has not been taught (e.g. Not each function of the spreadsheet is taught but at the test shall we check whether students can use an unknown function)?
- What should be asked at the final exam (school-leaving exam)? (Is it necessary to deal with the functions of the operating system? Analogy: Is the capability of adding graded at the mathematics school-leaving examination?)
- Motivating kind assessment.
- Practical and theoretical assessment.
- Tool/device-handling and problem-solving assessment.
- Assessing and grading team and project work.

The influence of assessment on the material to be learnt.

- In order to avoid unnecessary typing when applying, let us import the raw material. When executing a program, to avoid unnecessary amount of typing, let us read in the data from a file and write the result into a file. Therefore these functions should be taught earlier then otherwise necessary. What else alike is there?

The components of ICT approach, the background of ICT field of knowledge.

ICT lesson types, classroom and out-of-class activities.

- Lecture-like lessons.
- Independent work without using a computer.
- Computer-aided independent work.
- Team work: discussing the task in team, evaluating the solutions in team.
- Project work.
- ICT homework (with and without a computer).

Competitions, tenders, solving competition tasks.

- The curricula of competitions, methods of assessment.
- The relationship between curricula of competitions, the NAT and the school-leaving examination.
- The role of competitions in independent knowledge assessment.

The role of competitions in career orientation.

2. Objectives, skills and abilities

In our today's fairly informatized world it is beyond question that ICT education has a serious role in making young people become useful members of the society and live successful and content lives. However, the thing is not only to convey such knowledge to students that they will later be able to make good use of but we should endeavour to form such a way of thinking that will stand the test of time to the constant changes and which they will be able to use in various aspects of life.

A) Information-communication culture.

B) Modelling.

C) Processing information with intelligent tools.

D) Computer literacy.

E) Algorithmic thinking.

F) Users' approach.

G) The ability of turning information into knowledge.

H) The ability of creative application of information.

Why are certain ICT topics taught, which develops what skill and ability? Why are they taught to that very age group?

Why is ICT curriculum structured the way as it is? Are there other structuring methods possible? What other subject organisations are possible?

Does every one need the same ICT? The possible shifts in priorities within general ICT.

General ICT—technical ICT

Mathematics-oriented ICT: mathematical algorithms, mathematical applications, mathematical problem-solving, etc.

Science ICT: simulation, evaluation of measurement data, etc.

Social science ICT: text processing, text databases, searching the web, ICT in the library, etc.

Art ICT: drawing, audio editing, animation editing, photo editing, video editing, multimedia, etc.

Industrial ICT: measurement, controlling, regulation, robotics, etc.

How can general ICT prepare for professional and higher education (both in the field of computer science and in other special fields)?

How much does the curriculum help student understand the world?

What must students learn by heart? And why? When can they use aid? What has this got to do with the everyday use of computers?

Assessment.

Their aim; what has assessment got to do with the aims of development?

Is it possible to make assessment always objective (e.g. whether the prepared document is aesthetic or not), or if not, how can it be made more objective?

The possibilities of self-assessment, assessment without grading.

3. Teaching methods

The proportion of practice and theory.

The proportion of the ability of thinking, problem-solving abilities and the ability of tool manipulation.

Knowledge of tools, that of applying tools and that of application scope.

That is, for instance, handling a word-processor; using a word-processor to create various document types; and familiarity with document types.

Problem-solving method (based on György Pólya).

Analysing and understanding the task.

Planning the solution of the task.

Implementing the solution.

Evaluating the solution.

Constructing from bottom towards top or vice versa.

Teaching basic skills; and when having more basic knowledge synthesis.

The analysis of complex problems, and deducing from that what basic skills and knowledge are important to acquire.

The methods of teaching concepts; their advantages and disadvantages.

Inductive method.

Deductive method.

Constructive method.

The teaching methods of certain ICT areas.

The methods teaching programming: specification-oriented, algorithm-oriented, data-oriented, language-oriented, language type-oriented,

hardware-oriented, mathematics-oriented, task type-oriented, sample task-based.

The methods teaching programming languages: statement-oriented, language-oriented, using as a tool, software technology-oriented, action-oriented, task-oriented, sample task-based.

The methods teaching applications: menu-oriented, task-oriented, concept-oriented, function-oriented and application-oriented, as an abstract tool.

The methods teaching ICT tools (hardware, operating system, network): function-oriented, problem-oriented, operation-oriented, operation model-oriented.

Assembling curricula to the topics using the given teaching method.

Assembling task lists to the topics using the given teaching method.

ICT learning methods.

Assessment methods in ICT, their aims and usefulness.

Oral testing: short presentation, program or application presentation, a comprehensive overview of a topic.

Testing without a computer: tests, writing and analysing algorithms, writing functions, writing queries in applications.

Testing with a computer: lexical knowledge, reaching a set objective based on an example, problem solving in applications and with programming.

Testing in teams: problem solving in a team, independent parts of a greater task, continuing each other's work.

The relationship between assessment and computerisation: who deserves a better grade:

A) who is lazy, dumb and disturbs his/her classmates in the lesson, ..., but has a computer at home, and therefore knows a lot of shortcuts, who has a daily routine and can solve a lot of things quickly;

B) who is bright, smart, hard-working and prone to help his/her classmates, ..., but does not have a computer at home, and thus is slow in his/her use of the computer, and thus does not always complete tasks on time.

The possibilities of motivation in ICT.

Practicability, solving tasks that the given age group is interested in.

Independent creative work (can be taken home and shown to parents—i.e. it requires a printer, a colour one if possible).

The possibilities of independent discovery.

Using the experience of former students.

Sharing work in projects according to abilities.

Rewarding possibilities.

Solving useful tasks.

Teachers' learning.

The problem of fast changing software tools.

The appearance of new topics in ICT.

The problem of a student who has too high opinion of himself/herself: knows all menu items, all function keys, every function of a programming language, etc. by heart-so what makes the teacher more clever (the ability of abstraction, overview, etc.).

4. Tools

What is a good ICT classroom like?

Hardware devices and software tools in teaching ICT.

The educational aspects in choosing devices and tools.

Programming languages: the objective of teaching a language, linguistic simplicity, typicality, developing environment, usability, standardisation, security.

Application systems: the objective of teaching a system, simplicity, visuality, completeness, adaptability, reliability.

Operating systems: the simplicity of the user interface, hardware and software possibilities, functions of operating systems. User interfaces: command line interface, menu, icon-window, etc.

Application, communication and programming interfaces: text, icons-windows, etc.

The problem of Hungarian or English language software.

The complexity of tools and its dependence on age group.

Should we always teach the latest tools?

Evaluation: automatic or subjective? The tools of automatic evaluation.

Program evaluation based on runtime results (and several partial results).

Efficiency (choosing an algorithm, implementation) based on runtime results with time limit.

Application evaluation for a given period of time with too many tasks: the mechanical solution does not fit into the time limit, while the creative one does.

Students' choosing a tool when being tested (e.g. Drawing a Hungarian flag in Excel by sizing 3 cells and setting background colour).

The possibilities of team evaluation (evaluating each other's work).

The effect of the first tool (e.g. programming language, word processor, etc.).

The effect of the tool on good or bad application or programming style.

The difficulty of acquiring a second tool after the first one.

Does the tool have an effect on forming thinking?

5. The relationship among the participants of the learning process

Teacher—student relation (who directs, in what way, etc.).

The teacher as the source of knowledge, frontal teaching. A teacher cannot answer every question but must know how to find the answer.

The teacher as an adviser and helper: in computer lab classes among students—he/she corrects mistakes and wrong solving methods; helps when students get stuck, etc.

The teacher as a director: the designing phase at the computer lab, whereas in the solving phase he/she displays and evaluates the good and bad solutions prepared by the students.

What should an ICT course-book contain? What is a good ICT course-book like?

What kind of course-books do you need? Do you need a course-book containing modules or a course-book that lasts for a whole academic year?

Theoretical course-books or software descriptions? The role of ICT task-lists.

A course-book on a tool or a reference book describing a tool? (Analogy: grammar book or dictionary?)

Are students allowed to use their course-books when they are being tested? When and why? What is the knowledge they are expected to learn by heart and what must they be able to find quickly when necessary?

How can you use a good ICT course-book?

Should the teacher retell what is in the book or should the student read the book by him/herself, or perhaps should not read it at all (because it is used e.g. for finding information like a description of commands of a programming language).

Should a course-book be about theory or practice?

Electronic curriculum and course-book (not distant learning in general, but the special opportunities offered by ICT)

Course-book substitutes and their disadvantages.

Materials supplementing course-books; opportunities to use them.

Practice material, keys to solutions.

Does an electronic curriculum need a teacher?

6. The relationship between teaching and educating

Team work: discussing a task in groups, evaluating a solution in groups. Helping the person sitting at the next computer.

School ICT projects

Working out project tasks, structuring and organising projects.

The role of teachers and students in projects.

The participation of the talented in the teaching-learning process.

Helping role at classes in the computer lab.

Providing extra-help to students who lag behind or do not have a computer.

Passing new knowledge to the whole class.

Talent management.

Competitions, tenders?

Leading school projects (e.g. school papers/periodicals).

The curriculum of talent-managing after-school classes.

7. Efficiency, effectiveness

Levels:

Using a tool, choosing the tool, assembling a tool and developing a tool.

Routine, understanding, recognizing opportunities, intelligent application.

The knowledge that can be acquired when using certain teaching methods. How can it be measured?

What and how do testing methods measure?

How does the testing method affect the student being tested and the teaching method?

8. Other

A. What special parts of non-ICT fields of knowledge areas should an ICT teacher deal with?

Such fields of knowledge that are bordering ICT but there is not a related school subject to them at the given period of the learning process. For instance, the technical data of a computer in technology or computer-aided measuring, regulating and controlling in health education/life skills and practical skills in years 9 to 12 (15–18 year old teenagers).

Such fields of knowledge that are bordering ICT, and the borderline areas can principally belong to both subject. Here to decide which school subject is to deal with the given borderline topic is mainly determined by the fact

A) the teacher of which subject is more familiar with it;

B) which subject can find and allocate more time to it?

ICT could lay the grounds for the application side of the other subject (e.g. learning to handle a music-editing program in the ICT class, teaching a music-editing program in the music class), i.e. the most useful would be to teach it in both classes.

B. What special parts of ICT fields of knowledge should a non-ICT teacher deal with?

For instance, in a maths class the maths teacher might teach numeral systems, logic, etc. In physics class students can learn about circuits, etc., and in chemistry class information on data carriers, etc.

Methodology of Informatics

Methodology deals with the problems of teaching specific curricula, and seeks answers to the following questions in connection with a given part of the curriculum:

1. The teaching of a given part of the curriculum

A) How can it be explained that the given part of the curriculum needs to be taught? How can students be motivated?

B) What methods can be used to introduce new knowledge? How can the curriculum be structured?

C) How can it be related to previous knowledge? How can it rely on previous experience?

D) What examples are feasible to be used to teach that part of the curriculum?

E) How much and what kind of practice is necessary to acquire the knowledge? How do they depend on the depth of acquisition?

F) What kind of practice tasks can be given to accompany them?

G) What kind of testing can be used to check the acquisition of the part of topic?

2. Preparing concrete subject task-lists

A) How can one make new tasks from one task? How much can the solution of new tasks resemble the solution of the original one? How can one make a new task by altering the solution?

B) How can one construct a curriculum with one set of tasks?

C) How can one prepare such a test to a given topic that tests its every important aspect?

D) How can one weigh parts of the test; is it a problem to test something several times?

E) Analysing tasks, realising similarities, constructing tasks similar to the given type.

3. The problems of solving concrete tasks.

A) Realising typical mistakes/errors, correcting and avoiding them.

B) The question of measuring the progress when solving greater tasks.

C) How can teachers prepare students well for a given set of tasks (e.g. test)?

D) What are the special to-dos to be applied when preparing students for a certain form of testing? (I.e. What mistakes do students usually make? What are the typical things that are not understood? What do task-setters usually expect?)

E) Analysing the tasks of the school-leaving exam, analysing competition tasks.

4. Planning and organising ICT projects

A) How can one design project work to a school event applying ICT?

B) What kind of roles can students be given in a project applying ICT?

C) How can an ICT project be completed?

D) How can an ICT project be evaluated?

5. The ICT teacher's extra-school to-do lists

A) Communicating with the systems administrator (user identification, installing software, system set-up, etc.).

B) The regulations of ICT usage in the classroom, security questions.

C) Preparing for lessons (collecting and organising material, etc.).

D) The regulations of operation of the ICT classroom in and after lessons.

6. Developing curricula and teaching aids

A) What are the fields that need teachers' direct curriculum-preparing work (descriptions, example tasks, example solutions, etc.)?

B) Preparing visual aids.

ICT Subject Philosophy

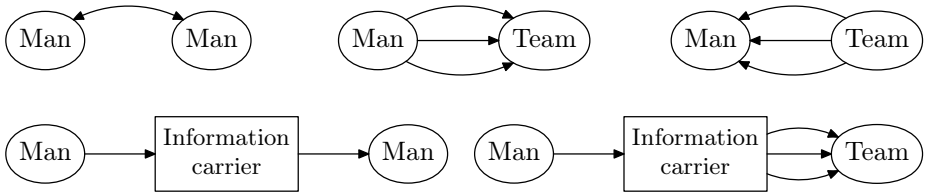
1. ICT as modelling

Just like in many other subjects, models are created in ICT, and we try to undertand and get to know real systems through these models.

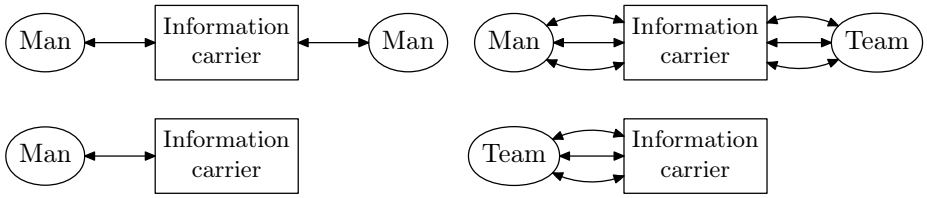
The peculiarity of ICT—as opposed to other subjects—is that here these models have to be implemented and operated with some intelligent device or tool. Moreover, applying the ready model is a complex—ICT—task.

2. ICT as a means of communication among people

Traditional communication:



Infocommunication:



3. ICT as virtual reality

Games in virtual spaces, interactive media.

Virtual worlds in learning, research, etc.

Visual models of the ICT world.

4. The information society and the man

5. Is there such thing as ICT intelligence?

6. What are ICT competences?

7. What makes ICT skills useful knowledge from social point of view?

ICT Subject Pedagogy

1. Educational principles in the ICT class room

The educational principles in an ICT class are different from those in traditional classes. The nature of the work done in an ICT lesson makes it impossible to keep such discipline and order than in other lessons where students use pencils and paper. The task of the teacher is more difficult, as well: on the one hand, he/she must try to keep an atmosphere where it is possible to work, whereas on the other hand, he/she must permanently satisfy the needs of individual students (my computer is out of order, my program won't run, etc.).

The role of the independent "evaluator" i.e. computer: can it teach students to order and to become well-organized, as well as to perseverance and systematic thinking?

2. Socializing role

ICT with its tasks for teamwork is an ideal field for teaching students to cooperate.

Competitive spirit and ICT, the role of individual and team competitions.

3. Communication

Using ICT and communication "rules of good behaviour": sms, mailing, mailing lists, chat, etc.

Question: Does Point 6 of ICT didactics belong here?

This area is probably closer to the general questions of pedagogy, and therefore can rather be included in here.

Summary

Above we made an attempt to categorize the area of subject methodology of ICT, to divide it into subfields. We believe that dividing it into four main areas is necessary and absolutely reasonable from professional points of view. We also gave details of the certain areas though we are aware that there are overlaps in several places. It is partly caused by the fact that these areas are related and only partly by the fact that it is not perfectly decided where certain parts belong to.

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LÁSZLÓ ZSAKÓ
EÖTVÖS LORÁND UNIVERSITY
FACULTY OF INFORMATICS
BUDAPEST
HUNGARY

E-mail: zsako@ludens.elte.hu

KATALIN JUHÁSZ
UNIVERSITY OF DEBRECEN
FACULTY OF INFORMATICS
DEBRECEN
HUNGARY

E-mail: nyako@inf.unideb.hu

ZOLTÁN KÁTAI
SAPIENTIA–EMTE
TÎRGU-MUREŞ
ROMANIA

E-mail: katai_zoltan@ms.sapientia.ro

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