THEORETICAL & PRACTICAL RESOURCES OF E-LEARNING

Jana Kapounova, Jiri Pavlicek

ABSTRACT
At present a rapid development of learner-centred instruction can be observed, in which participants are less dependent on teachers. Of great significance are the quality of study materials as well as programmes supporting self-study. Our objective is to summarise the theoretical concepts, to analyse sources of content, to assess the methodical background and to search for technical solutions in the context of e-learning. Is it possible to reformulate former courseware? Is it possible to develop an effective methodology of transformation of former courseware which might be an asset to authors of e-learning study materials? In the present paper we want to introduce our project concerning the above mentioned questions.

KEYWORDS
Information and Communication Technology (ICT), Educational Cybernetics, teaching machine, Programme Instruction, courseware, e-learning

INTRODUCTION

Today's technology enables a text, sound and a picture to be integrated. Multimedia computers and electronic communication offer new perspectives. The use of computer networks is gradually opening doors to virtual universities. Demand for study materials of good quality, is much higher than potential authors' capacity to create them. Also, this might result in inferior quality study materials, which do not respond to the rules of e-learning.

BACKGROUND

Theoretical concepts for e-learning have been covered in detail in many countries, where computer based learning has been very popular with teacher trainers and teachers themselves from the very beginning. The roots date back to the time of first experiments with aids "automating" some repetitive teaching procedures and with technical support of the selected didactic technologies. The knowledge of didactic technologies has been augmented, clarified and improved since then. At the same time, it was educational packets that came into existence, whose technical production was in accordance with that level of technology: teaching machines, computers of the first generation. It was also then that the first attempts of multimedia instruction were undertaken.

HISTORICAL VIEW

At the beginning of the sixties, the basis of "mathematical pedagogy" was laid in our country. It was at the Pedagogical Institute in the town of Karlovy Vary in former Czechoslovakia. The discipline was developed

according to that of "mathematical psychology" which was popular in the U.S.A. We can mention Prof. Antonin Svoboda and his lectures about the possibilities of application of cybernetics in the theory of education. Further ideas on cybernetics in instruction came from England (G. Pask) and Germany (H. Frank, H. Kelbert). Eventually the new discipline was called Educational Cybernetics. In the meantime, many efforts were made to construct new teaching machines and suitable instructional programmes in various subject areas, at different types of schools and types of learning. Theoretical approaches were tightly connected with practical activities from the very beginning.

Research interest in Programme Instruction was aimed both at theoretical approaches and at the sequencing of subject matter. It was typical of the era (about 1963) and it sound funny to our young students now, which subjects were chosen to be programme instructed for our first teaching machines: psychology, Russian language, Marxism-Leninism, mathematics, physics and chemistry. Let us mention some first Czechoslovak teaching machines: KT1 to KT3, Unitutor, Hvezda (Star), etc. The main gap existed between the broad didactical intention and the limited functions of the teaching machines.

Mutual influence among German (F. von Cube, H. Frank,…) English (G. Pask), Russian (L. Landa) and Czechoslovak researchers was fruitful also in development of the theory of supersigns.

After 1968, many of the pedagogical researchers who had been involved in those projects left Czechoslovakia. Some of them continued their work abroad.

INITIAL SITUATION

The technical foundations, however, were very much behind the theory and above all, they were not available to teachers in schools. Despite this fact, a number of elaborate works were brought into existence, as well as a great deal of instructional programmes. It was only multimedia personal computers with user friendly graphic interfaces that created the optimal technical basis. Unfortunately, the teachers who acquired the qualification in didactic technologies along with the necessary practice often showed "the generation barrier" preventing them from gaining ICT proficiency. As the first computers were introduced in schools, plenty of computer programmes, though with trivial technical solutions but rich in the content and ideas were developed. Their authors were often computer fans who were also teachers with the necessary practice.

Another problem is that all the knowledge is published in a variety of sources – in old volumes, in university series, internal publications of research institutes, and everything in low numbers of copies. The above materials are difficult to access nowadays.

Technical solutions are favourable these days. But what is more difficult at the moment are conditions for creating and spreading quality courseware. As some of the older work shows, there is a very good level of didactic materials on various themes; hence, it seems to be appropriate to deal with the source and ways to updating them.

PROJECT

A research team from three Czech universities has been formed. The aim of the common project is to summarise the theoretical concepts, to analyse sources of content, to assess the methodical background and to search for technical solutions aiming at the use of all these for e-learning. In our project we want to explore various possibilities on how to transfer the current courseware into electronic form and to evaluate the efficiency of the procedure. If it is proved effective, we want to create a methodology of this transformation process.

Specifically, we aim to

- Summarise the theoretical concepts.
- Collect a representative sample of educational materials suitable for innovation and for use in e-learning.
- Determine of procedure for courseware transformation into electronic form.
- Create a selection of titles and their transfer.
- Verify innovated courseware in pedagogical practice.
- Formulate methodological instructions.

STEPS IN THE PROJECT

According to the project plans we have completed the following:

- collection, analysis and compilation of theoretical concepts of computer aided learning
- at the same time collection of suitable courseware
- database of gained information. With field, e.g.: name of the product, author(s), type (book, thesis, contents (key words, content,…), way of treatment (programmed, linear, hypertext,…), facilities (photos, charts, diagrams,…), medium (paper, tapes,…), range, date of issue, application, deposition, evaluation, intelligent use, ect.
  We will store about 1000 records during 2003.

Analysing the collected material we will:

- search techniques inevitable for transformation of selected titles into a form meeting the requirement of e-learning
- choose titles for innovation according to particular criteria. A sample of titles, which will be transferred and verified, will cover a wide spectrum of courseware: different media (older programmes for machines Unitutor,…); intended for different users (grammar school, universities, self-learning,…); for different topics (maths, language,…)
- determine an output form for each type of selected courseware
- realise an actualisation of courseware.

In our research we want to continue with:

- experimental verification in different types of schools and with different users
- formulation of methodology of courseware transformation.

Possibilities offered by modern multimedia computer technology, computer networks, digitisation of sound and picture can support innovation of courseware and its use in e-learning. On the other side, there are theoretical issues on computer-aided instruction and many educational applications, which are technically primitive, but their contents and methodology may have practical use. Both might be an asset for development of new study materials for e-learning.

E-LEARNING

A number of e-learning definitions can be found in the theory and practice of using computers in education. We will show three of them; the most general and most in use is the first one. However, in our topic the third view will be preferably used. That "didactic" definition uses the following aspects

- a system aspect
- a pedagogical aspect
- a technological one, in the sense of ICT tools and environment.

However, let us start with the first definition, which is based on e-processes (electronic-oriented processes):

- e-learning (electronic education) is the series of learning and teaching processes, which are delivered and operated by electronic tools.

As the second, the technology-based definition is as follows:

- e-learning means computer/web based training (CBT/WBT), a learning management system (LMS) and communication tools, i.e. computer based training, its management and communication within the system.

And eventually the didactic definition:

- e-learning = ISD + learning concept + ICT, i.e. e-learning means the connection of a systematic design and a suitable learning model in the ICT environment.

At the end of the definition part we will add an easy explanation (Zlamalova). She regards e-learning as an educational method, since it represents a content and a learning strategy via electronic tools, namely by the use of some other methods than those usually used in class.
We have found that the priority of the pedagogy in e-learning has to be emphasized anytime and anywhere. Especially focusing on a community of e-learning developers is fundamental. E-learning is first of all about pedagogy, says Saul Carliner in OnLine Learning News. However, if you browse through themes of many conferences and seminars on e-learning, you get an idea that you want to participate in ICT events.

At the same time we see that emphasizing a systematic approach to designing learning process for instance the way this is used in the field of Instructional Design (ID) is needed as well. Of the well-known ADDIE approach only DI is left in many cases (Galvin). It is good to realize that content is Queen and context is King (Keegan). Our priority is content and learning strategies. In the first instance, we start with summarizing how we see some drivers of the design of instruction. This view will form our way of creating procedures for transforming the courseware in further phases of the project. We shortly mention

- Instructional Design as a discipline
- ADDIE, a macro strategy of design process
- Learning strategies and learning styles
- Structured design and modularity
- ID techniques
- Development tools

INSTRUCTIONAL DESIGN AS A DISCIPLINE

Period	***Instructional Media***	***ID-Instructional Design***
1940‘	audiovisual instruction	ID origins, US Army-World War II, Gagné
1950‘	CAI-Computer Assisted Instruction (IBM)	Programmed Instruction (Skinner, 1954), Objectives Taxonomy (Bloom, 1956), first author language (IBM)
1960‘	CAI at universities, CAI systems (PLATO, TICCIT), Pask (1960)	Objectives Theory (Mager, 1962), Criterion-Referenced Testing (Glaser, 1963), Domains of Learning, Events of Instruction (Gagné, 1965), general system theory (GST, Silvern, 1965), instructional systems
1970‘	Ditto	ID models (Dick&Carey, Gagné&Briggs), graduate programmes in ID, military, industry
1980‘	microcomputers, teaching computer skills	little impact on schools, cognitivism, use of microcomputers for instructional purposes and to automate some ID tasks (Merrill, Li), CBI-Computer Based Instruction,
1990‘	CD-ROM, multimedia, Internet, innovative learning	constructivism, authentic learning (Dick), Internet, distance learning, KM-Knowledge Management

The table gives us an idea of a history in the field of Instructional Design since World War II. The history in Czech countries is important for our project, since it brings the potential resources.

The field of Instructional Design stipulates the following for us: Instructional Technology is the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning (Seels&Richey, 1994) (see Reiser). The terms might be confusing. Even if the definition refers to the field as instructional technology, the literature tells us that Instructional Design, Instructional Technology, Instructional Development, etc. are understood in the same meaning.

We consider Instructional Design to be a system of procedures for developing educational programmes. The form of instruction delivery is not important at the moment.

ADDIE, A MACROSTRATEGY OF A DESIGN PROCESS

Most ID models reflect the methodology of the Instructional System Design (ISD). ISD specifies ID in a system view and determines phases in the process of designing instruction. The short for it is the well-known ADDIE approach (Analysis, Design, Development, Implementation, Evaluation). Those phases form core elements of the ID process, sometimes they are used as a step-by-step procedure. We show ADDIE in a diagram, which emphasises the central role of evaluation in the process (Reiser). In such a view, the evaluation plays a formative role and gives feedback for a permanent revision of the design process. ISD brings the conceptual model of ID.

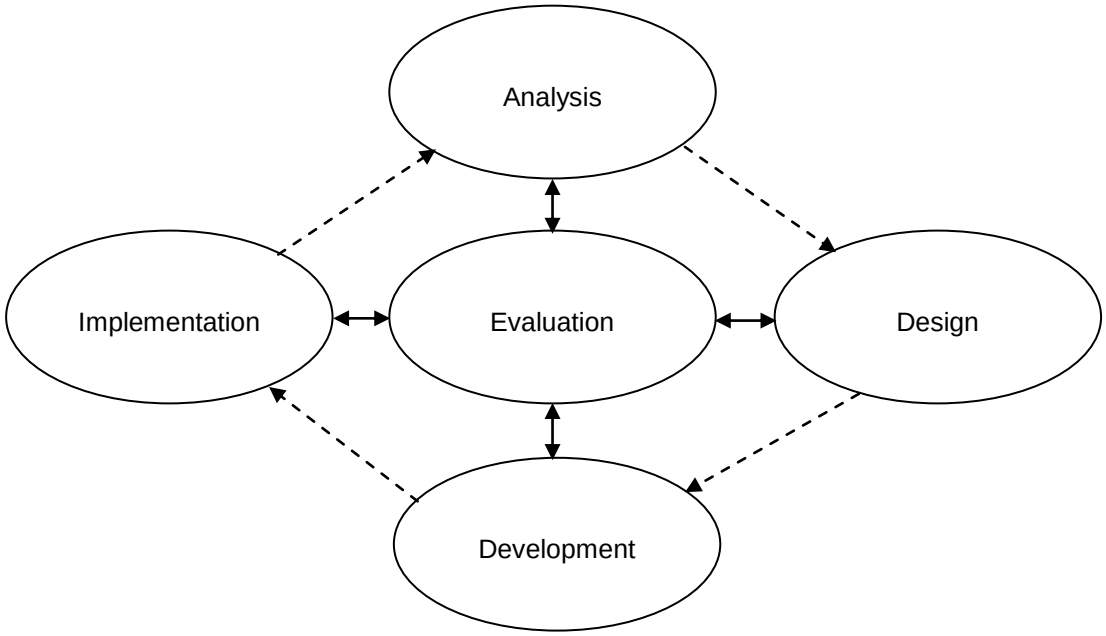

Figure 1. Instructional System Design model

We also reminded of discussions ”ISD yes or no” (Zemke, Rossett). ISD is said to be rigorous, slow, boring, leading also to a wrong view of the world, and so on. On top of that, ISD does not correspond to a mentality of the present generation with mobile phones and the Smiles language. That can be true, but ISD brings an assurance of results and traditional pillars. And if we see it then as

- learner-centred
- focused on real-world performance (authentic learning)

and accept the needs of team efforts in the process of design and development, we cannot see any alternative way for instructional design. Nor is it hidden behind the need of e.g. rapid development.

E-learning, as a way of teaching, has a huge impact on a large audience. It is our concern to add to make content "learnable".

The authors want to stress they are ISD advocates. Among theirs goals is not only use it in the project, but also to introduce the field as a study programme at universities in the Czech Republic. In this context we think the delivery of e-learning courses, but the fact is that "I" means implementation of all kinds of teaching.

LEARNING STRATEGY AND LEARNING STYLES

Allow us to try to specify a relationship between learning styles and learning concepts. We will construct a learning strategy matrix. Why do we do that?

- We claim (as others do), that some kinds of learning are suitable to be algorithmiced, and that ID can be seen as a craft (based on routines), not as an art (based on creativity, or ad hoc solutions). Exactly stated procedures can lead to guaranteed results of learning. And this is our aim due to the above-mentioned huge impact of e-learning. To do that, we must accept a certain idea and model how the learning process is operated.

Table1. Learning strategy matrix

	Learning concepts		
Learning styles	*Behaviourism*	*Cognitivism*	*Constructivism*
receptive instruction	x		
directive instruction	x	x	
guided discovery		x	x
exploratory			x

- The table shows us what kinds of learning procedures shall be used in what events (we used learning styles defined by Ruth Clark, see Merrill). We are also advocates of individualization of learning methods; computers make this possible. Every person can find and choose the easiest and the most efficient way of learning. And such a customized path can be found not only from the point of view of intellectual or psychomotoric processors, but also according to receptors the particular person prefers to use in the learning process (see TriM, Three Representational Modes learning theory, Marzano). Multimedia can be used for this.

STRUCTURED DESIGN AND MODULARITY

Transformation procedures will be based on a structured design of learning and the principle of modularity. Both the methods can contribute to instructional design. Both of them are very close to pursuit of standardization in e-learning. (IEEE, Institute of Electrical and Electronics Engineers' leads this process, see Hodgins.)

Modularity leads to building libraries of learning modules and reusable learning objects (RLOs). That way it also leads to the so call rapid development. The modular approach is based on the decomposition of a

problem. Functionally independent modules are built and then connected with data, e.g. entry and output knowledge or skills. Learning modules form the first level of modularity. The second level of modularity is the level of learning objects, i.e. texts, graphic objects, animation, video, and sound. Modules make building courses easier. See the following scheme:

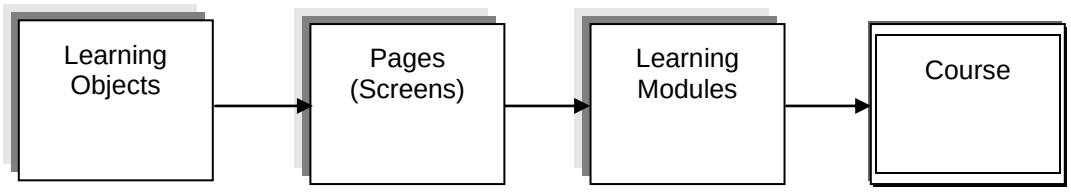

Figure 2. Modularity

Structured (composite) **design** brings looking for a structure in the learning process, makes algorithmisation of learning possible, helps us to find a limited number of control structures. The structured design usually starts with structuring objectives in the sense of objective components (performance, performance quality, conditions, gauge). Objectives are then transformed into learning modules based on the learning triangle.

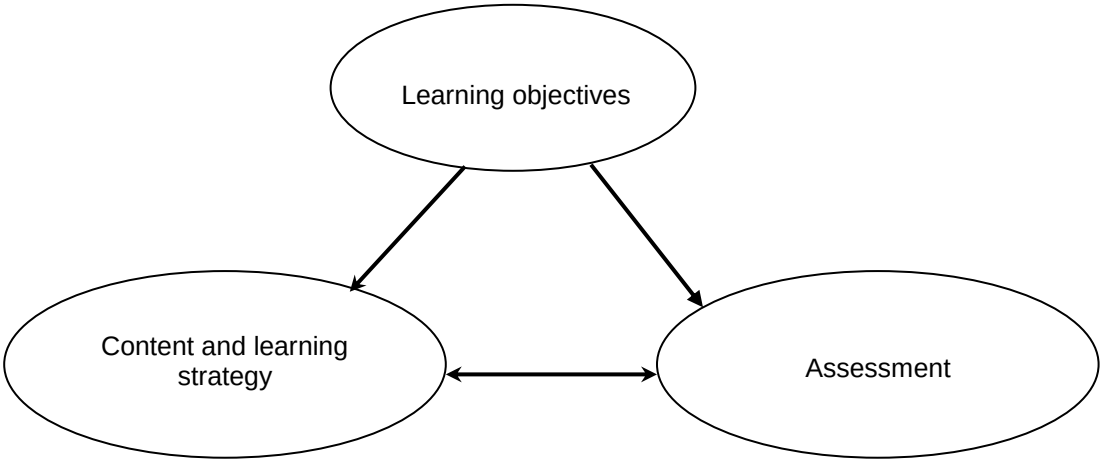

Figure 3. Learning triangle

Structure implies the decomposition of a problem or situation. Founding basic control structures and the algorithmisation will make the fast transformation of courseware possible.

A basic specification of the course structure can be formulated according to the nine events of learning, as Gagné stated them (see Clark). The course starts with gaining attention, (the best way is to use questions or stating a problem), then it continues with drawing objectives, recalling prior knowledge, presenting information, providing guidance, eliciting performance, giving feedback, assessing performance, enhancing retention and transfer.

Other structures arise from dividing the learning process into presentation, practising, revision, and assessment.

The primary way of the structure of learning modules is sequencing (see Gagné again). Besides, we use

- branching, mostly based on the level of entry knowledge, but even on the access to problem solving
- layering (Horton), according to the depth of learning (needed to know, good to know, nice to know).

Both the structured approach and the modularity in learning are thought to be important instruments for learning programmes development, and also for courseware transformation.

ID TECHNIQUES

Instructional design can be supported by suitable techniques. We will remember here the following examples:

- sets of questions
- tables
- hierarchical diagrams
- flow charts.

At the end of the design process is a product, which can be called course model (see Clark). It serves as input to the development of instruction. Simply, it is a set of tables and diagrams.
Predefined **questionnaires** (see Clark, ASTD) are good to use in the phase of analysis. This includes, for example, needs analysis, task analysis, analysis of learners (target group). So as not to forget any important circumstances, it is useful to construct and use some kinds of templates. E.g. preparing needs analysis means forming questions on current level of knowledge or skills, comparison with our expectations, finding a solution. Analysing a target group means asking about age structure, sex, experience, cultural differences, motivation.

Tables or context matrix give us another instrument. As an example, we will show here how to use the table for the description of objectives. Objectives are described in terms of students' performance (Tollingerova).

Table 2. Description of objectives

Objectives	***Operationalisation***	***Quality***	***Conditions***	***Metrics***
Objective 1				
…				

Hierarchic diagrams are suitable for problem structuring. They fit in a description of objectives and their projection into a course structure.

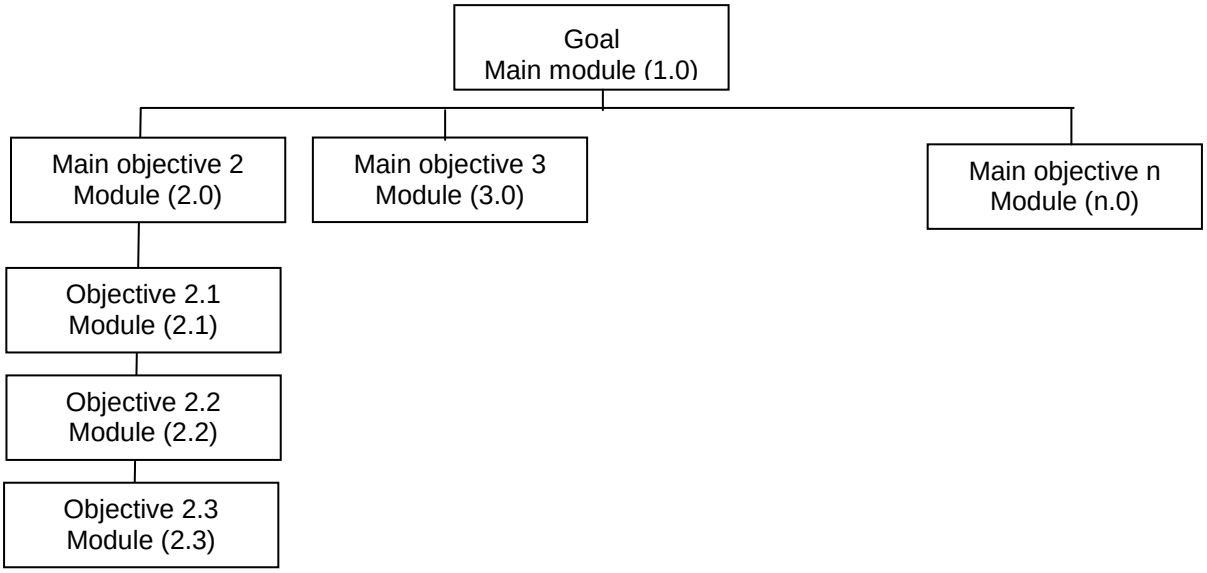

Figure 4. Course hierarchy

HIPO diagrams (Hierarchical Input Process Output) are other tools; it is convenient to use them for a description of individual modules. Functions of modules are described by process and appropriate inputs and outputs. On the lowest level they serve as an instrument for defining screens (pages) of a CBI programme. A set of such diagrams is called a storyboard.

Table 3. HIPO diagram

Module 2.1		
Input	***Process*** *(a learning strategy)*	***Output***
knowledge	tell……	knowledge +
skills	show……	skills +
data	ask……	data +
….	do…….	….
Navigation	Objects for navigation	

Note: + indicates a positive change

Flowcharts are good for drawing relationships within learning modules. They describe processes in a graphic way. Flowcharts are convenient for drawing the strategy. It is good to include them into HIPO diagrams. The example shows a learning strategy based on principles of programmed learning.

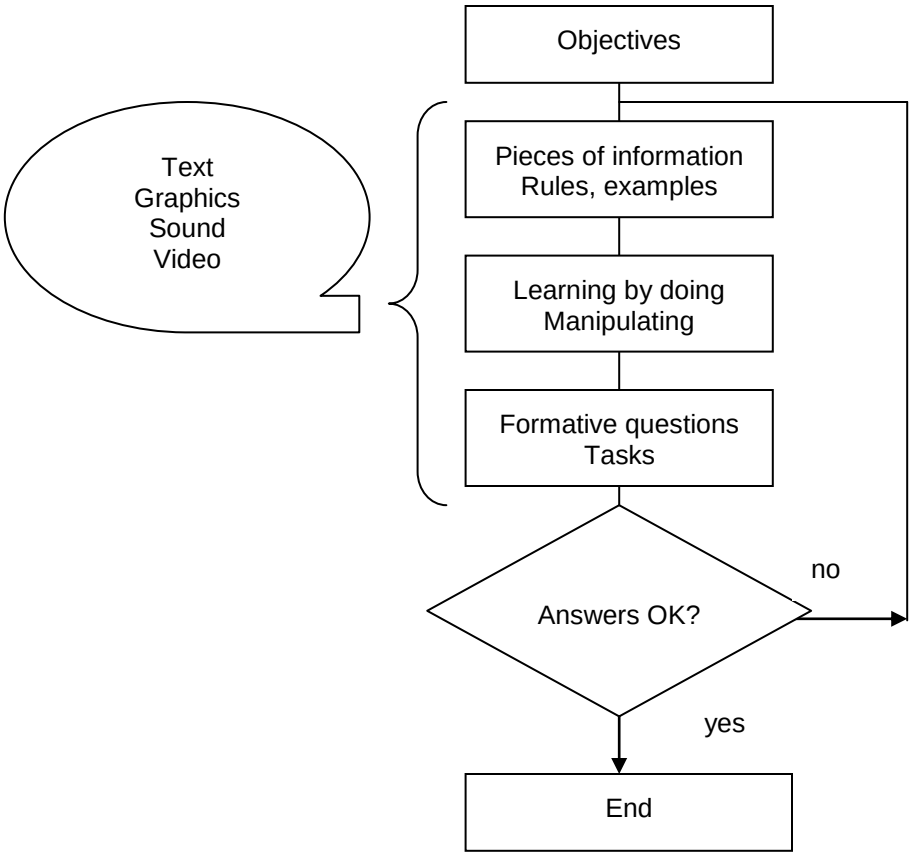

Figure 5. Learning unit - programmed learning

The tools we showed form a set of effective instruments for creating a **model** of a course and a **storyboard**. They contribute to using a clear language for the description of learning.

DEVELOPMENT TOOLS

ID tools discussed above imply the possibility and necessity of using automative tools for learning design and development. All of them can be put into effect on computers as a part of authoring systems. If we go through existing software, we meet templates and other tools for rapid development.
The effort of bringing existing old courseware to life, which we can call **re-elearning,** has to be supported by automative procedures. Existing tools of authoring systems and other techniques will be used for copying, restructuring and redeveloping.
In any case, enlightenment follows this discussion. From the point of view of the course life, the final product (CBL course, instructor-led course) itself is not as much as the product, which we called the course model, or the course design, including the objectives, structure of learning, the strategies and assessment.

CONCLUSION

From the project we expect a review of theoretical paradigms that have their sources in philosophy, psychology, pedagogy, didactic technology, information and communication technology.
At present there is a big demand for quality and study supports for e-learning. We want to demonstrate that it is possible to innovate using former courseware, which might be an asset. In case the transformed courseware does not prove to be suitable for distance courses, which are often very specific in their orientation, another chance is offered. Computer based instruction is helpful not only in common classes but also in education for people with special needs, no matter how handicapped they are (either physically, mentally or socially). The paradigm of computer aid in learning is important not only from the technical point of view. Experience with learning along with feedback can support the development of knowledge and the required study habits.

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Jana Kapounova
University of Ostrava
Ostrava
Czech Republic
Email: Jana.Kapounova@osu.cz

Jiri Pavlicek
University of Ostrava
Ostrava
Czech Republic
Email: Jiri.Pavlicek@osu.cz