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Theoretical Concepts, Sources and Technical Background of E-learning

Abstract

The topic *Theoretical Concepts, Sources and Technical Background of E-learning* is discussed in a project of the Czech Science Foundation. A research team from three Czech universities (University of Ostrava, Charles University in Prague and University of West Bohemia in Pilsen) is working on the project. Its aim is to summarise theoretical concepts, to analyse sources of content, to assess methodological background and to search for technical solutions how to transfer some titles of current courseware into electronic version and to evaluate the efficiency of procedure. The methodology of transformation can help authors of study materials (not only e-learning), they may benefit from old instructional programmes.

Key words: *Information and Communication Technology (ICT), programmed learning, teaching machines, courseware, e-learning, Learning Management System (LMS), learning object.*

Introduction

At present a rapid development of learner-centred instruction can be seen, in which participants are less dependent on teachers. Of greater significance are quality study materials as well as programmes supporting self-study. Today's technology enables a text, sound and a picture to be integrated. New perspectives are offered by multimedia computers and electronic communication. The use of computer nets is gradually opening doors to virtual universities. Demand for study materials, in particular quality ones, is much higher than authors' potential capac-

ity to create them. It might result in inferior quality study materials which do not respond to the rules of e-learning.

Theoretical concepts for e-learning have been covered in detail not only in the world, but also in our country, where computer-based learning has been very popular with teacher trainers and teachers themselves since the very beginning. The roots dated back to the time of the first experiments with aids "automating" some repetitive teaching procedures and with technical support of 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 the level of technology – teaching machines, computers of the fist generation. It was also then that the first attempts at multimedia instruction were made.

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

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

All this means that the potential should be estimated and made available. Technical solutions are favourable these days. But what is more difficult at the moment is conditions for creating and spreading quality courseware. As some of the older works show a very good level of didactic materials on various themes, it seems to be appropriate to deal with sources and ways to update.

E-learning and programmed learning

The question arises whether the above link is meaningful and what, if so, both the concepts have in common. Presumably, this relation is not causal in any respect, and both the terms are not at the same level of conceptual hierarchy in their

semantic or temporal dimensions. The discussion about e-learning often looks back on programmed learning, which sometimes leads to badly asked questions and to mixing educational environment, teaching theories or strategies.

E-learning

A number of e-learning definitions can be found in the theory and practice of computer-aided instruction. We will show three of them, the first being the most general and most used, however, in our topic the third view will be preferably used:

- e-learning (electronic education) is a series of learning and teaching processes which are delivered and operated by electronic tools.
- e-learning means computer/web based training (CBT/WBT), learning management system (LMS) and communication tools, i.e. computer based training, its management and communication within the system.
- e-learning means the connection of a systematic design and a suitable learning model in the ICT environment.

We have found out that the priority of pedagogy in e-learning has to be emphasized anytime and anywhere. Particularly, focusing on a community of e-learning developers is fundamental. It can be briefly characterized by a quote by S. Carliner: "E-learning is about pedagogy."

E-learning and its sources

There are a number of teaching theories and conceptions from which behaviouristic conceptions of programmed learning and cybernetic interpretation of pedagogy have been applied and developed a lot.

Programmed learning is based on well-known principles formulated by B. F. Skinner in the 1950s, and on the paradigm S (stimulus) – R (response) – Rf (reinforcement), which appeared in a range of educational programmes incorporating particular procedures, such as linear programmes by Skinner and Pressey, branching programmes by Crowder, forward branching programmes, etc. The behaviouristic theory of learning was used by Skinner to formulate principles of programmed learning, on whose basis an elaborate methodology (model, architecture) of programmed learning was created, which implements receptive and authoritarian learning styles. Sometimes, they are called instructive learning styles.

Let us mention D. Tollingerová and V. Kulič, who became renowned for their works in our country. Tollingerová deals with solutions to problems of formal language to describe instructional algorithms, then solutions to designing an educational programme according to aims analysis by means of defining learning activities and tasks, which is based on Bloom's taxonomy of aims. She shows ways of designing instruction linked with contemporary technology which is still efficient and used by plenty of instruction designers.

Cybernetic approaches in pedagogy are, on the other hand, represented by M. Lánský. He dealt with programmed learning and, along with German pedagogy, he was actively involved in educational informatics. Their works bring about methods to prepare, realize and assess computer-aided instruction as well as methods in problem learning.

The above-mentioned sources and some further theories and conceptions are methodological tools for designing e-learning instruction.

Thus, e-learning is seen as electronic environment to implement instruction and the instruction means realizing teaching and learning processes.

To clarify the concept of e-learning, we define individual elements of educational reality, and at the same time, we assign potential e-learning (computer) representation. Here we use components of the instructional model as stated by Frank (1996).

Table 1: Elements of educational system (Frank, 1996) and their representation in e-learning

Elements of educational system	Representation in e-learning
Aims of instruction (Z)	Aims in computer instructional programme
Content of instruction (L)	Content of computer instructional programme
Learner (P)	E-learner, learner and his/her computer
Material resources (M)	Software, multimedia, the Internet
Methods (B)	Strategies in computer instructional programme
Educational environment (S)	LMS, virtual reality, computer lab, e-learner and his/her e-experience

Similarly, if we analyse any other models of educational process, e.g. Blížkovský (1997), Poláková (1999), we are always able to find out their electronic representation.

We have specified the phenomenon of e-learning and showed relations and realization of educational components in this instructional environment. While analysing relations between programmed learning and e-learning, we will point

out basic principles of programmed learning and state potential implementation of these principles in electronic environment.

Table 2: Principles of programmed learning in e-learning

Principles of programmed learning	Representation in e-learning
Learner's activity initiated by a question, clue, constructed answer	Interaction and management by events of computer instructional programme
Reinforcement	Reward can be realized and programmed in computer instructional programme
Individual pace	Programme management by events initiated by learner
Small steps	Programme management by events initiated by learner
Management authoritarian, by errors, adaptive, performance testing	Management by events of instructional programme, or by adapting to events initiated by learner, tests

As we can see, all the above-mentioned principles can be implemented in computer environment. In terms of programmed learning, the educational process is convergent and algorithm-able, which eventually led to realizing programmed learning by means of didactic tools such as a programmed book, scrambled text and a wide range of teaching machines. If we compare a programmed book, a scrambled text or teaching machines with computer environment, it is obvious that programmed learning can be fully implemented just in the electronic environment of computers, which precisely realize computer programmes, i.e. instructional algorithms in this case. And since the 1990s we have added hypertext, multimedia properties and the Internet. Hypertext and hypermedia make non-linearity (branching, adaptiveness) possible. In addition, multimedia head for using sensoric learning styles and implementing a number of didactic principles in instruction management (e.g. principle of clearness). Furthermore, the Internet is able to make communication within a new educational community more efficient, which means a variety of instruction management.

To sum up, *e-learning creates a suitable educational environment for realizing instruction on the principles of programmed learning.*

Learning objects and metadata

We come across the concept of learning objects more and more often. We regard it as a cornerstone of instruction as well as the concept of designing instruction. An example of a learning object is a paragraph of a text, a question, animation, but also a complete sequence of instruction. A learning object is a representative of the

instruction content, knowledge, or cognitive entity, whether it is a fact, a concept, a procedure, or a rule. The ranking of learning objects gives rise to an instruction unit, which is usually an organizational grouping of learning objects into an instruction whole that is specified by the aim of instruction and pedagogical phases (pedagogy, didactics), exposition, practice, diagnostics of goal achieving. An instruction unit might be a module, a chapter, a lesson, a course.

The point of this lies in such a good description and preparation of learning objects so that they can be easily refound anywhere, then reused feasibly in any environment of Learning Management System (LMS).

The basic standard for work with learning objects is Learning Object Metadata (LOM). It is the outcome of the group in the Institute of Electrical and Electronics Engineers' (IEEE) Learning Technology Standards Committee (LTSC) Learning Object Metadata Working Group. The standard of LOM is a springboard for some other working groups dealing with metadata and objects for e-learning instruction. One of them is a group called Advanced Distributed Learning, which gave rise to the specification SCORM (Shareable Content Object Reference Model). These groups add components to the standard of LOM which suit a particular community of learners or learner profiles. As the system of metadata of the standard LOM is flexible, the above groups seek consensus in description, they refer to implementations and publish the best examples of using learning objects.

The basic entity in the SCORM model is a shareable content object. This object is made up of one or more assets. An asset means digital instruction content, a text, a picture, animation, sound, a video sequence, a web site, assessment. An important property of an object in SCORM is that it can be launched in LMS. The objects are described by means of the system of metadata.

How we are going on in our project

Programmed learning has had an impact on the conception of education in the Czech Lands, the evidence of which is a file of learning objects compiled within our project.

In the course of our project solving we carried out:

- collection of suitable courseware, all data are saved in designed database;
- some techniques inevitable for transformation of selected titles;
- choice of titles for innovation;
- determination of output form for each type of particular courseware;
- transfer of courseware;

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

Collection, analysis and compilation of suitable information

We systematically upgrade information about
- theoretical concepts of computer aided learning;
- suitable courseware or products for programme instruction;
- bibliographic search.

All the data are stored in the database, which was designed and created in our research establishment.

Verification of transformed teaching aids

After the product database had been analysed, the aids were selected for the purpose. Before we started transforming them, we had to make slight alterations to some products while trying to "revive" them. Sometimes, the technical state of the aid or the device did not enable us to update it.

Table 3: Examples of courseware transformation

Name	Original Source (Device)	Done by	Present Medium
Baroque in Prague	diaphone	PowerPoint	CD-ROM
Health Safety and Protection	diaphone	Tool Book	CD-ROM
Czech Language	diaphone	PowerPoint	floppy disk
Physics Electric Circuit I to III – Photographic Camera – Microscope – Binoculars – Magnifier – Structure of Atom – Radioactivity	teaching machine KE30	HTML file	CD-ROM
Physical Laws and Principles I Physical Laws and Principles II	8-mm film 8-mm film	film	DVD DVD
First Aid	specific courseware	Tool Book	CD-ROM

Pilot verification in specific schools

The selected schools in which the above titles were verified included those in the cities of Ostrava, Prague and Pilsen, both elementary and secondary – grammar schools and apprentice centres.

We devised a procedure of experimental verification of transformed products and a questionnaire for the teachers involved.

The questionnaire consists of

- Background questions – they include information about the teacher, school, subject and themes, students, a form of instruction.
- Questions about the verified product – its content, technical quality, didactic quality, didactic value of the electronic form of the programme.
- In the free part teachers can express their own views and comments, or share experience and observations.

The teachers involved in verifying the transformed titles were very positive, which sometimes gave the impression that they missed "old good" teaching aids. The worse technical quality or "old-fashioned" environment is basically treated with indulgence. Furthermore, they praised the didactic quality of the product. Also, the electronic version of the product is easier to start and steer.

As regards similar product transformation in their own workplaces, problems would probably appear on entering. E.g. use of old tape recorders or projectors of 8-mm films is no longer possible in most schools, whereas output devices, such as a computer with DVD can be found in most educational institutions nowadays.

As far as the technical solution is concerned, we can conclude that particular courseware

- can be transformed in almost every school, although a certain amount of skilfulness, a lot of time and software are needed, some tasks can be entrusted to students

  Example: soundtrack transformation from old records and tapes, etc. into the digital form (e.g. *.mp3 files).
- can be transformed only in a specialized establishment which is well equipped, and must be done by experts

  Example: copying of old films needs an appropriate projector, cleaning device, digital cutting apparatus, etc.
- must be utterly technically changed, but we will make use of teaching potential, ideas, pictures, sound and text commentaries, etc; some tasks might be done by students, others by specialists

  Example: diaphone-like products, which were initiated by a diaprojector along with a tape recorder, can be transformed by means of some software

for making presentations (from MS PowerPoint to Authorware) and then stored on DVD.

Problems with copyright

Conversions of instructional packages do not involve only technical problems but also questions in the field of laws (at least the copyright), ethics, contents (at least relevance to the contemporary school curricula), etc.

Therefore the project study also comprises the interpretation of copyright, especially "Author Law". In addition, the complex of FAQ – frequently asked questions, groups of similar problems are consulted with a lawyer.

Conclusions

Possibilities offered by modern multimedia computer technology, computer networks, digitalisation of sound and picture can support courseware innovation. However, the question is how to pinpoint further steps of integrating the innovated courseware into e-learning study support.

In the project we tried to transfer some current courseware versions into modern electronic media. The transferred products were tested in real instruction. The technical solution of transfer is feasible in most courseware even though in a few cases it is time-consuming and, in terms of material equipment, quite demanding. Their pedagogical and didactic content is a huge asset.

Part of the project was to gather and describe didactic resources, such as diaphones, instructional movies, video programmes, programmed textbooks, scrambled texts. In addition, we searched for methodological aids, i.e. articles, textbooks, generally speaking, publications on the problems which were discussed.

All the entities were termed learning objects, by which we mean any entities which can be used in the educational process. It is somewhat debatable whether to classify publications as learning objects, nevertheless, they can be described as such by means of metadata. The aim of describing learning objects was to give them descriptive data which, later on, enable a user to work with the objects , using them either directly or vicariously via conversion to a digital environment.

As much effort is currently being made in the field of ICT – aided education in terms of standardization, we consider storing some of standardizing data in libraries of educational establishments. One possibility is the digital library DILLEO

(which was implemented at the University of Hradec Králové). Thus, we made the outcomes of our project accessible to the general public.

Note: The metadata of the library DILLEO is based on the specification ARIADNE – *Alliance of Remote Instructional Authoring and Distribution Networks for Europe.* The library DILLEO is meant to meet requirements of the university community.

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