Who Shall Guide Education Process – Teacher or Technology

Boris Aberšek, Metka Kordigel Aberšek
Faculty of Natural Science and Mathematics, Faculty of Education, University of Maribor,
Maribor, Slovenia
boris.abersek@uni-mb.si, metka.kordigel@uni-mb.si

Abstract

Evolution in computer and information communication technologies have made also possibilities to develop intelligente technological solution for enhanced learning. Today, most researchers in the field of educational technology seem to be preoccupied with either heuristic, the development of some hove intelligence application, or the philosophy and psychology, concerned with the nature and scope (limitations) of knowledge and representation or varius learning theories such as behavorism, constructivism and conectionism by computer program. The enthusiasm to develop technological advanced learning tools resulted in technologies with limited application. The need to develop simple computer-based tools to assist instruction and demonstrate its impressiveness to enhance learning is most important, but those tools desperetly need to be designed with didactical and methodological knowledge and only hardly then integrated into a pedagogical framework.

The paper presents the design and use of an interactive computer-aided learning tool for enhanced learning. In this paper we also present the impact of an interactive computer-aided e-learning tool whose primary objective is to assist students in learning.

Keywords


Introduction

A serious limitation in the traditional (lecture) approach in education is the fact, that it mostly places the student in a passive role. What influences student’s experience is briefly shown at the Figure 1. One of the basic questions facing educators has always been "Where do we begin in seeking to improve human thinking?" Fortunately we do not have to begin from scratch in searching for answers to this complicated question. The experts recommend: "One place to begin is in defining the nature of thinking. Before we can make it better, we need to know more of what it is". New discoveries in the field of developmental cognitive science and neuroscience hold a great promise for improving current teaching methods. Yet there remains a significant gap between the scientific discoveries that could improve our education system and the application of this knowledge.

Because the whole education system is too complicated for one paper, we will take into account in this paper only one pillar (see Fig. 1), that is learning environment. Today the probably most important element of the learning environment is information and communication technology (ICT). ICT through e-learning, e-lab, networking, knowledge-based systems, and other technologies, will play an increasingly important role in the way that education is taught and delivered to the student,
especially to science and technology students. But all this modern technology must have base on special didactics and media didactic. Through these technologies and didactic, the student will be placed in an "active" role, as opposite to a "passive" environment of one-way lecturing. The teacher can then act as a facilitator and author of the learning environment instead of merely a one-way communicator (Novotný, 2011).

There is no denying about the appeal of computer and other ICT technologies. Their magnetic effect on students’ attention is all too familiar to teachers but parents too, particularly when the alternatives are boring homework and household chores (Massey and Brown, 2005). If we would like to use this entire new gadget, we must know:

- **something about the end user, that is how human intellect works and/or how human percept individual information, and**
- **something about technological possibilities, that is how advance learning environment must be built up.**

And we can put also some additionally basic questions about processing of information:

- How can understanding of the information processing help to be a better teacher?
- What assumptions about learning underlie this process?
- What is metacognition and why is important that teacher understand it?
- What kind of study strategies will help students to learn?
- What teaching strategies can one use to help facilitate meaningful learning?
- Etc.

But let’s start from the beginning. A lot of research in education is concerned with the development of intelligence applications such as Computer-Aided Instruction (CAI), Intelligent CAI, Intelligent tutoring system (ETS) and Intelligent Learning Environment (ILA) (Felder, 1993; Allen, 2008) and also with applications that can be justified as being consistent with educational theories. There is also a new trend which deals with comparing the performance and attitudes of students taking online courses versus those taking lecture-based courses (Davis, 2003, Sunal, 2003). Computer-supported collaborative learning (CSCL) is one of the most promising innovations to improve teaching and learning with the help of modern information and communication technology. Most recent developments in CSCL have been called e-Learning 2.0, but the concept of collaborative or group learning whereby instructional methods are designed to encourage or require students to work together on learning tasks has existed much longer. It is widely agreed to distinguish
collaborative learning from the traditional “direct transfer” model in which the instructor is assumed to be the distributor of knowledge and skills, which is often given the neologism e-Learning 1.0, even though this direct transfer method most accurately reflects Computer-Based Learning systems (CBL) (Stahl, 2006).

**Information processing system**

Locus of Control remains an important consideration in successful engagement of e-learners. According to the work of Cassandra B. Whyte, the continuing attention to aspects of motivation and success in regard to E-learning should be kept in context and concert with other educational efforts. Information about motivational tendencies can help educators, psychologists, and technologists develop insights to help students perform better academically (Whyte, 1980).

It seems that advancements in the use of technology for educational purposes have bypassed two major elements: the integration of computer based applications in the instructional process and vice versa, and consequently the transforming the role of instructor. While many perceive online computer-aided learning tools a major breakthrough in teaching and learning, many educators and trainers do not support it (Conlon, 1997). Although the growth of online computer-aided learning tools has been significant recently, there still exists a major gap in design and evaluation of their educational (teaching and learning perspectives) capabilities and effectiveness in enhancing the learners’ experience (Saade, 2007).

![Diagram of information processing system](image-url)

**Figure 2: Model of information process**

Broadbent (1958) proposed a general model of the human information-processing system as briefly shown in Figure 2. This information processing model presented the basic mechanisms: three main memory storages in which the information is operated on, and the processes of transforming the information from input to output within each storage and from output to input between these storages. The model suggested that the processing is a fixed serial order from one memory storage to the next, and voluntary control of the system was represented by a selective-attention device and by information feedback loops from the high-level processing system to earlier processing stages.

There are many different theories about the human information-processing system, but probably the most widely accepted theory is labelled as the “stage theory”. It is based on the work of Atkinson and Shriffin (1986). The stage model assumes that the brain embodies a nervous system that processes the information from the time of the input to the time of storage in long-term memory. The system comprises three main stages that contain different physiological properties: the
sensory registers, short-term memory and long-term memory. The sensory registers briefly store representations of external stimuli from the environment until the information can be transferred further. There appears to be different sensory registers for each sense. In any case, the sensory registers can hold information for only a very brief period of time. The information is assumed to be lost from the registers unless it is passed along into short-term memory.

Short-term memory can be thought of as conscious memory because, in addition to holding information, it allows information to be manipulated, interpreted and transformed. The new information in short-term memory, by subjection to further processing, may be transferred to and made part of long-term memory. Long-term memory is a relatively unlimited and permanent repository of information. Long term memory stores for later use of information. Once the information is stored in the long-term memory, it stays.

The information processing model highlights the basic mechanisms in terms of stages and the processes, and the representation and storage of information:

1. Three main stages in which the information is operated on: sensory memory, short-term memory (temporary working memory), and long-term memory.
2. The processes of transforming the information from input to output within each stage and from output to input between these stages, e.g. attention/pattern recognition, encoding and retrieval.
3. Representation and storage of information, e.g. network models, Feature Comparison Models, Propositional Models, Parallel Distributed Processing Models, etc.

**Theory into practice: The influence to instructional systems design**

Two key assumptions in information processing theories have great influence in the formulation of instructional principles:

- The memory system is an active organized processor of information
  1. Research studies in attention and perception, such as the pattern recognition filter models of attention, and dual coding theory, have great impacts on the instructional message design both in text and visual message in order to maximize the attention and perception of the learners.
  2. Studies in the characteristics of short-term memory, such as limited space and short duration, give rise to the importance of mnemonic devices to reduce the workload of the short-term memory, information organization in chunks or smaller components to increase capacity. Also, the information processing models proposes the use of rehearsal strategies to maintain information, and content organization, such as elaboration theory, to help encode information by relating incoming information to concept and ideas already in memory.
  3. Theoretical explanations on the retention in long-term memory emphasize the effects of different conditions on levels of processing. Meaningful encoding facilitates later retrieval. Graphic representations have been particular effective in facilitating encoding and memory storage of information
- Prior knowledge plays an important role in learning process
  1. The influence is evidenced by the use of advance organizers and any instructional strategies to strengthen activation of the existing memory structure. Elaboration strategy and Ausbel's meaningful learning employed in instructional design systems
suggests the importance of relating meaning of the new information to each individual learner. Also, the use of the metaphors and analogies provides instructional effectiveness.

2. Emphasize the importance of self-regulatory skills in learning: conscious reasoning and thought

Moreover, with the development of information processing view of learning, the task can be examined from the perspective of human thought process. The cognitive operations that a learner needs to carry out in order to complete a task or to solve a problem become the target of analysis. Information processing task analysis uses flowcharts to represent cognitive operations step by step and indicate the decision making process (Scandura, 1973).

The conceptualization of an active memory system puts a lot of attention on the operation of information. The focus is on what and how this system is related to learning and cognition. In this framework, a lot of different hypotheses are proposed to explain different types of memory systems, the representation/structure of knowledge in memory, and how these representations influence and interact with incoming information. In turn, those hypotheses provide implications on how to control the instructional conditions. The assumption is that the correspondence between the instructional conditions and the internal conditions of this active memory system will maximize the effectiveness of the instruction.

Theoretical results

Today, the term “computer-assisted learning” is used loosely and represents the utilization of any application for delivering content to the student. This may be: electronic material that students would read or interactive learning tools to help learning. Concerns currently being explored by researchers include student’s attitudes, course design and delivery, course evaluation, and instructor behaviour and attitudes (Sunal, 2003,achtmaier, 2003, aberšek, Kordigel aberšek, 2010). The effectiveness of computer-assisted learning applications and utilization of well-developed research plans are relatively scarce at this time (Sunal, 2003). As we mentioned, any computer-aided application/learning tool, especially intelligent computer-based tutoring system (the tutoring system of the future) must have in general level two parts:

1. The first part is heuristic part. Generally heuristic refers to experience-based techniques for problem solving, learning, and discovery. Heuristic methods are used to speed up the process of finding a satisfactory solution, where an exhaustive search is impractical. Examples of this method include using a “rule of thumb”, an educated guess, an intuitive judgment, or common sense. In more precise terms, heuristics are strategies using readily accessible, though loosely applicable, information to control problem solving in human beings and machines (Pearl, 1983). In computer science, metaheuristic designates a computational method that optimizes a problem by iteratively trying to improve a candidate solution with regard to a given measure of quality. Metaheuristics make few or no assumptions about the problem being optimized and can search very large spaces of candidate solutions. However, metaheuristics do not guarantee an optimal solution is ever found. Many metaheuristics implement some form of stochastic optimization.

2. The second part is epistemological part, connected with the philosophy, pedagogy and didactics. Epistemology is the branch of philosophy concerned with the nature and scope (limitations) of knowledge. It addresses the questions: what is knowledge? How is knowledge acquired? How do we know what we know? Much of the debate in this field
has focused on analyzing the nature of knowledge and how it relates to connected notions such as truth, belief, and justification. It also deals with the means of production of knowledge, as well as scepticism about different knowledge claims. The term was introduced by the Scottish philosopher James Frederick Ferrier (1808–1864). In our paper, and in epistemology in general, the kind of knowledge usually discussed is propositional knowledge, also known as "knowledge that". This is distinct from "knowledge how" and "acquaintance-knowledge". For example: in mathematics, it is known that \(2 + 2 = 4\), but there is also knowing how to add two numbers and knowing a person (e.g., oneself), place (e.g., one's hometown), thing (e.g., cars), or activity (e.g., addition). Some philosophers think there is an important distinction between "knowing that", "knowing how", and "acquaintance-knowledge", with epistemology primarily interested in the first.

At the executive level the intelligent computer-aided learning tools are interactive computer programs which incorporate expertise and provide advice on a wide range of tasks (Aberšek, 2004, Aberšek, Popov, 2005). These systems typically consist of the following three basic components:

- the behaviour of the problem domain,
- context is a workspace for the problem constructed by the inference Mechanism from the information provided by the user and the knowledge – base and
- inference mechanism, which monitors the execution of the program by using the knowledge - base to modify the context.

In addition to the three main modules described above, the system should also be provided with a graceful:

- user interface,
- explanation facility,
- knowledge - acquisition module, as shown in Figure 3.

![Figure 3: Configuration of the Expert System (Aberšek, 2004)](image)

The major research questions that guided our study were:

1. Does the e-learning tool have a measurable effect on students learning?
2. What is the impact of the e-learning tool usage on students’ performance?

In other words, we seek to investigate if there are any usage-performance associations. While using the e-learning tool, the score and the time of complete interactive session were measured. This
embedded the investigation of possible association between students’ time to complete a session and corresponding application scores.

Results: The e-learning tool, design and methodology

The study, we shall introduce as a example, examined the impact that the e-learning tool may have on learning. The primarily objective of this case was to allow students to explore different perspectives to concepts by manipulating related information. The aim of the exercise was to provide the student with an opportunity to construct his/her own mental model of a specific concept. This objective has some elements of the constructivist approach (Dalgano, 2009) and entails the implementation of learning strategies designed to involve the student in the learning process as well as a relatively high level of interactivity with instantaneous feedback. The e-learning tool was developed so that students could practice and assess their knowledge and assess their knowledge of content material and concepts to a specific matter (Jones, 2007).

In using the e-learning tool, students rehearse concepts specific to a subject matter by having the application prompting them with multiple choice, true or false and fill-in-the-blanks questions (Figure 3).

A rehearsing process entails a double randomization procedure, one type of question level and the other at the actual question level. After logging into the main page of the e-learning tool, the student can select which specific concept he/she wishes to rehearse. The e-learning tool now selects from a pool of related questions also using the same randomization function. The student answers the question; the time to answer the question is logged and feedback to the answer (correct or incorrect) is given to the student. Another question is then selected by the e-learning tool using the same procedure as described above. The session continues till the time is completed. After that a student gets a detailed performance report and an overall performance score.

![Flow Chart](image)

Figure 4: Flow Chart of the QUESTION-ANSWER process between students and system

The study examined the impact that the e-learning tool may have on learning. Two groups were used from two different semesters. Students were involved as a part of the Design and technology...
Curriculum at the faculty of Natural science and mathematics, University of Maribor. A total of 34 students participated in the study. Once again: the mayor research questions that guided this study were: Does the e-learning tool have a measurable effect on students learning? And what is the impact of the e-learning tool usage on students’ performance? Our research is consistent with the prior results where interactive computer based tutoring system - CBTS was been shown to positively impact students learning (Wegner, 1999, Aberšek, Kordigel, 2010). The results of the study are also consistent with previous research suggesting that students who use some kind of tutoring system for self-learning/evaluation higher in exams that those who use traditional study methods (Aberšek, Kordigel Aberšek, 2011). Table 1 presents the performance statistic of the study.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Min score in %</th>
<th>Mean (SD)</th>
<th>Max score in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A: With CBTS</td>
<td>46</td>
<td>75 (11.00)</td>
<td>94</td>
</tr>
<tr>
<td>Group B: Without CBTS</td>
<td>35</td>
<td>66 (12.00)</td>
<td>82</td>
</tr>
</tbody>
</table>

There is a clear indication that Group A shows better results than Group B. This indicates that the application influenced students learning, this enhanced learning is reflected in the minimal, maximal and consecutiveness in the mean score and indicate difference of 14%.

Conclusion

Information technology, through networking, knowledge-based systems and experience based system, artificial intelligence system and other technologies will play an increasingly important role in the way that knowledge is taught and delivered to the student. Through these technologies, the student will be placed in an "active" role, as opposite to a "passive" environment of one-way lecturing. The teacher can with the help of information technology, through networking, with knowledge-based systems and experience based systems, artificial intelligence systems act as a facilitator instead of merely a one-way communicator.

Computer based learning tools create a compelling experience. For application seeking to teach users through realistic experience, computer based techniques can make the experience much more memorable. In a test bed environment, the context and control afforded by intelligence design techniques, intelligent heuristic allow integration of technologies and evaluation of the overall experience, even with partial implementation. And we must point out, that for good and effective e-learning tools the philosophical and didactical part is equally (maybe even more) important than heuristics (technological, ICT part), since the history proves, that schools had been and can work also without ICT, but ICT without pedagogy and didactics is empty and useless.

Reference


Davis, R.S. (2003). Learner Intent and Online Courses, The Journal of Interactive Online Learning, Volume 2, Number 1, pp. 23-34


