The Use of Computers to Address Diverse Learning Styles in Chemical Instruction

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Abstract

The paper presents how instructional computer materials are suitable for the chemistry learning process. It presents an inventory of learning styles that include dimensions indicating learners' preferences for perception, presentation, organization, processing and assimilation of information. The paper describes how instructional materials used for chemical education are tailored for different learning styles.

Key words: learning styles, chemical education, computer assisted instruction

Introduction

When skillfully combined, pictures, words and sounds have the power to evoke emotions, change attitudes, and motivate actions. Examples of this power can be seen every day on television: the commercial that motivates the viewer to buy a product, the political spot that attempts to sway a voter's choice of candidate. We have been accustomed to live in a world of mediated impressions. The impression combinations of pictures create that, words and sounds have been shown to be retained by viewers significantly longer than when they are only heard or read.

Instructional media also make use of the power of pictures, words and sounds to compel attention, to help an audience understand ideas and acquire information too complex for verbal explanation alone and to help overcome the limitations of time, size and space.

While the advantages of using instructional media have been recognized for a long time, their acceptance and integration within instructional programs have been slow.

Computer environments are the biggest exception from this statement. The media's advantages are deeply exploited by computer technologies through multimedia materials that should be used in various educational situations.

Our paper's aim is to describe how instructional computer materials are suitable for the chemistry learning process.

The potential of multimedia in education can not be fully exploited without a better understanding of its role in the learning process. The paper presents an inventory of learning styles and an example for chemistry learning process. We considered the learning styles provided by learners' preferences for perception, presentation, organization, processing and assimilation of information and are influenced by four major stimuli: environmental, emotional, sociological and physical-perceptual-strength. Learning styles are examined with respect to some computer materials used for chemistry learning.

Learning styles

The learning style is the manner in which various elements in one's environment affect learning. Style refers to a "pervasive quality in the behavior of an individual, a quality that persist though the content may change" [1]. All learning styles are influenced by four major stimuli: environment, emotions, sociological, physical-perceptual-strength.

The *environment* for learning is provided by the user-interface features. The user interface through its components (interactivity, display elements and connection between them, colors and highlighting) is the only mean for learner to communicate with the computer. The term of "environment" carries with it the connotation of influence. The interactivity provided by the material can influence the communication between learner and computer or between learners or learner and teacher. The display elements, colors and highlighting affect the visual clarity of the application, influencing the instructional quality of the material.

The *emotional* component provided by the instructional materials is included primarily in the motivation for learning with the particular material. Different types of instructional materials provide internal and/or external motivation so, learners have the opportunity to be motivated in their own mode.

From a *sociological* point of view, each learner has own preferences: working alone, in teams or with peers. Using software for 1:1 instruction or communication tools can cope with those preferences.

From the *physical-perceptual-strength* point of view, the instructional materials delivered by computers, should be tailored to learners through the organization of information in order to assure different kind of perception and processing of information. It is well known that learned information is retained longer if the student is an active participant in the learning process (rather than a passive "absorber") and if the presentation involves several of student's senses.

Considering students' learning preferences for perception, presentation, organization, processing and assimilation of information, R. Felder [2] described 10 learning styles grouped from 5 presented dimensions. These dimensions are continua, so that a learner may show a strong, mode4rate or weak preference in any or all of them.

If we consider the perception of information, the learners are *sensing* or *intuitive*. There are studies [3] reporting that people retain about 25 percent of what they hear,45 percent of what the see and hear, and 70 percent of what they see, hear and do. In this direction, the benefits of multimedia applications assure efficiency in the instructional process. The sensing learners prefer information that comes from external sources (through their senses), for example facts and data. They prefer demonstrations, case studies and virtual laboratories presentations. The intuitive learners prefer internal information from theories and interpretation, abstract information.

The presentation of information can be *visual* and/or *verbal*. This is the dimension in which multimedia most excels. Well-designed instructional courseware can provide multiple representations of information such that the needs of both visual and verbal learners are served. Visual learners prefer pictures and diagrams to the written and spoken words and verbal learners prefer written and spoken words.

The information should be organized such that it begins with specifics then proceeds to generalization (for *inductive* learners) or in the opposite direction (for the *deductive* learners). The computer materials may deliver one or both manners for information organization.

Information processing is another dimension, which classify *active* and *reflective* learners. The active learners process information by interacting with others, they have preferences for cooperative learning. The well-designed instructional materials involve students in cooperative/active learning activities. Computer-based presentations can favor reflective learners (who prefer to process information introspectively), particularly if the classroom conditions discourage interaction (dark, anchored seats etc).

The assimilation of information is *sequential* or *global*. The sequential learners built understanding moving from one piece of the whole to the next in an orderly fashion and are able to use information in partial form. The global learners need to see the "big picture" before they are able to make use of the parts. The computer-based instructional materials can favor both categories of learners. Maybe the most considerably boon for the global learners is the Internet where the learning paths are totally non-sequential.

Examples for chemistry learning

For example, learning about "Le Chatelier's Principle", students can use different learning paths. This is a topic from chemistry curricula that engage different levels of information representation. At the macroscopic level, the observable one, the chemists think, for example at the amount of products or reactants of chemical reaction. At the microscopic level there are involved the concepts, theories and principles needed to explain what is observed at the macroscopic level. Chemists think about what atoms and molecules "do" during chemical or physical change. The symbolic level deals with formulae and mathematical calculations. Models of the world that are based on knowledge and operations involving description or explanations of chemical phenomena that have been translated into a different symbolic form (mathematical or verbal form). This level is most common to chemists because it involves using symbols (or either a chemical or mathematical nature) to represent a chemical phenomena. When conceptual computer animations are used in conjunction with other kinds of computer applications, students are better able to make connections among the microscopic, macroscopic and symbolic levels of representation.

Some screens from two instructional computer materials [4], [5], [6] are presented.

Considering the environment for learning, it can be noticed the user interface for the computer materials. The information is presented in an interactive and attractive manner. The interactivity is provided through a large range of activities (navigation through material, problem solving) that learners have to do. The simulations of chemical phenomena, where learners can manipulate, control, and see their effect, also provide the interactivity (figure 3).

The materials offer internal motivation to learners by providing immediate feedback for each action. This can be viewed in figure 5. The student can pass the sequence only after he responded correct to the exercise provided. In this manner, the student can manage his/her learning, can know every moment if he/she master the own knowledge. The analyzed computer materials do not offer examples for external motivation like "gifts" (music, animation and so on).

Global learners can choose the path and the steps he/she wants to follow from the map presented in figure 1. They have the flowchart of the topics and lessons and have the opportunity choose a non-linear investigation of the subject. By clicking a button, the learner can "jump" directly to the desired point without having to navigate through the whole learning section. The sequential learners have to follow the instructional material step by step, on the way established by the authors. In both situation the students can take the decision about learning path alone or under teacher's advice.

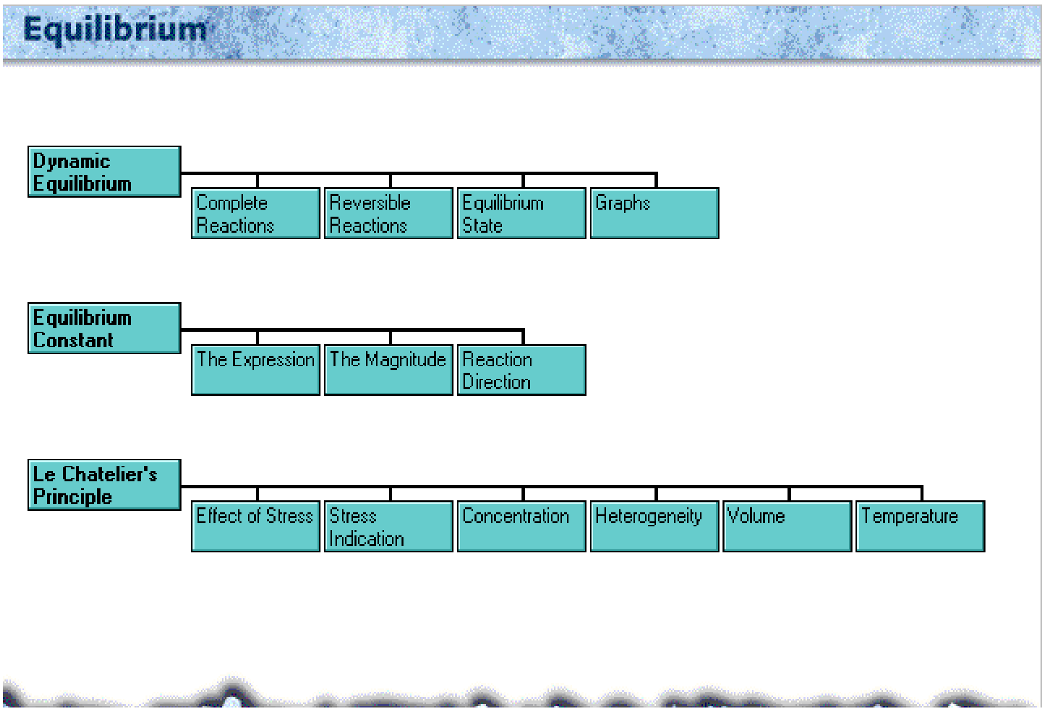

fig 1. Sample of screen for a flowchart of the lesson topics [3]

The manner of presentation of information provided by the analyzed materials is presented in figures 2, 3, and 4.

The verbal learners can choose written words about the item discussed (figure 2). For this category of learners the essential elements of the taught topic (the principle enunciation) is marked by another type of characters than those used in the body of the text. But this kind if instructional material is criticized in the literature of the domain and is referred as "electronic page turner". Using such materials, learner is a passive "absorber" of information.

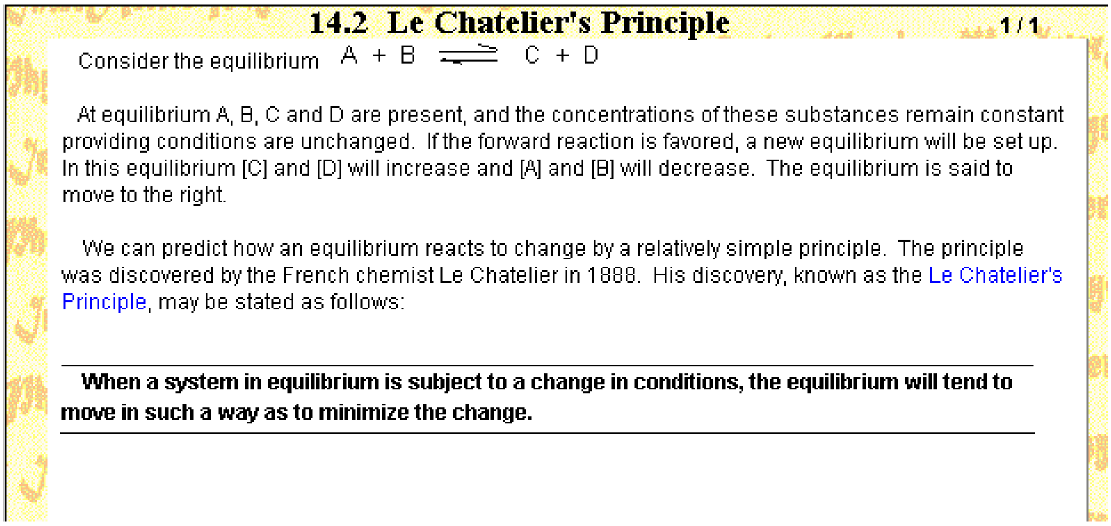

fig.2. A screen presenting the topic "Le Chatelier's Principle" [4]

The visual learners prefer pictures and diagrams like those presented in figures 3, 4 and 5.

In figure 3 is presented a simulation of the equilibrium process. The sensing learners can prefer this. Learner is guided through the steps of setting initial conditions values, running the simulation, and analyzing the results.

Learner is encouraged to think independently about the phenomena and to draw conclusions about the observed thinks. This simulation gives the learner the ability to visualize the chemical process and explore the effect of changing parameters on the operation of the system. In order to process the information, both active and reflective learners are encouraged; the information can be processed independent or in teams. This screen shows that for information deliver, the material provide macroscopic, microscopic and symbolic level of representation. At the macroscopic level, in the analyzed screen is presented that the reaction takes place in a container of fixed volume. At the microscopic level, while it runs the simulation, it is presented what atoms and molecules "do" during chemical and physical changes. The symbolic level deals with formulae and mathematical calculations. This level of representing information is better exploited in learning sequence such as that presented in figure 4.

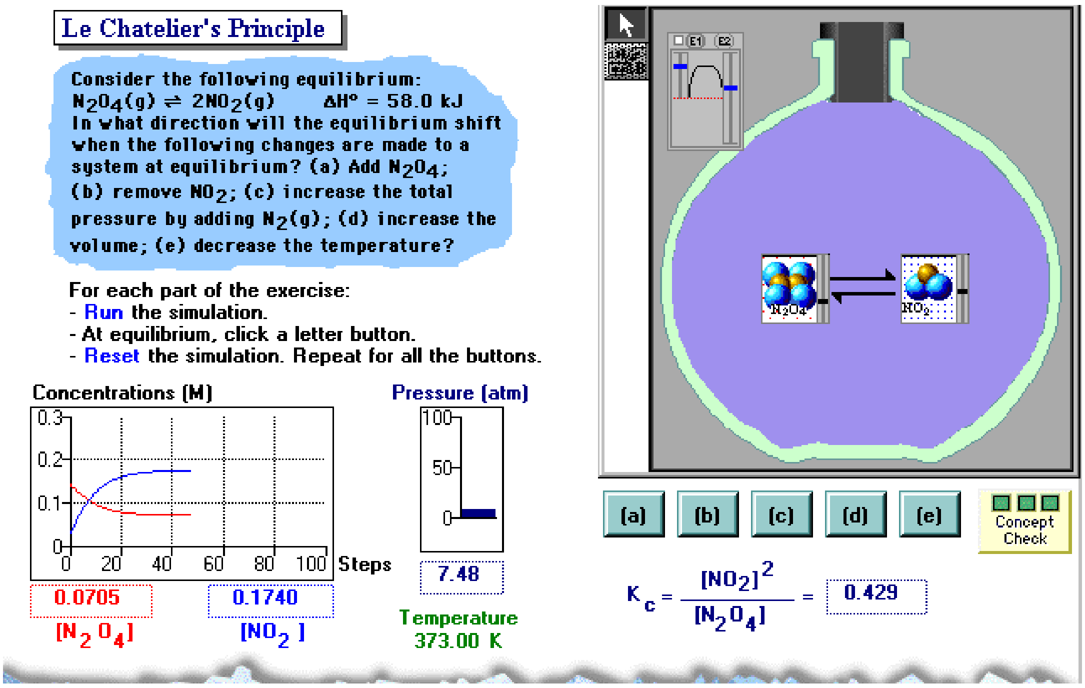

fig. 3. A screen presenting a simulation for the topic "Le Chatelier's Principle" [3]

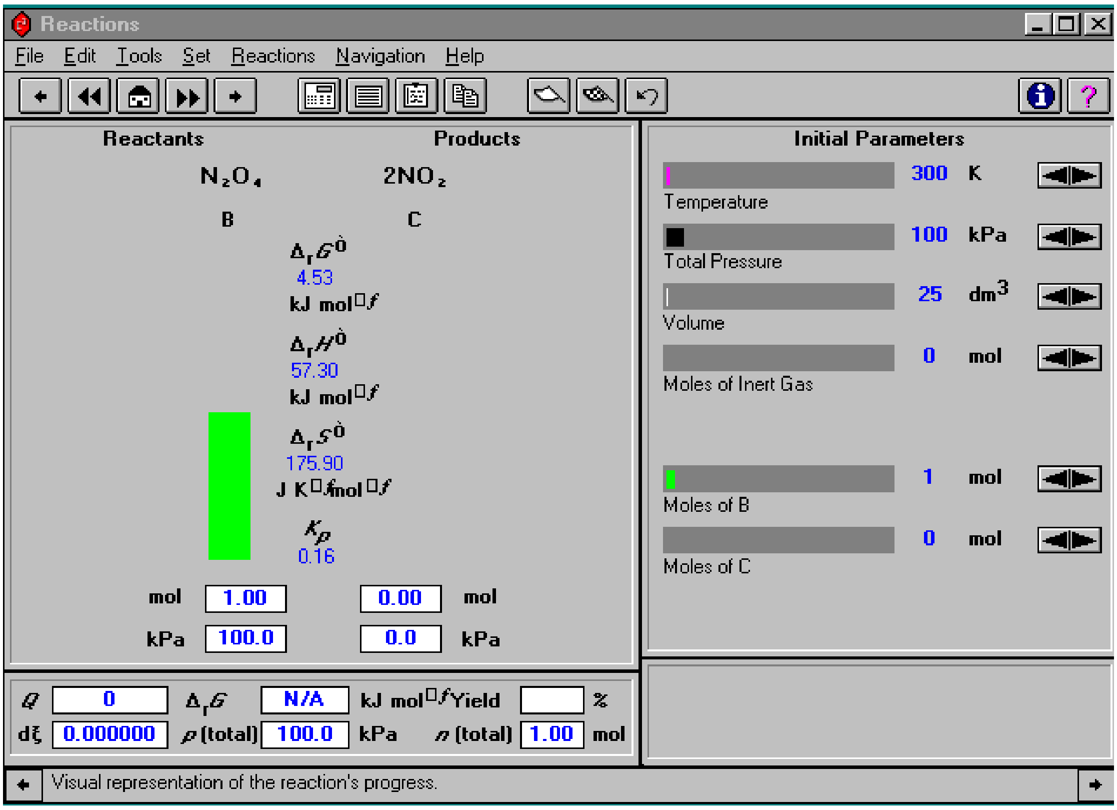

fig. 4. A sample of screen representing a learning sequence involving the symbolic level of knowledge representation [6]

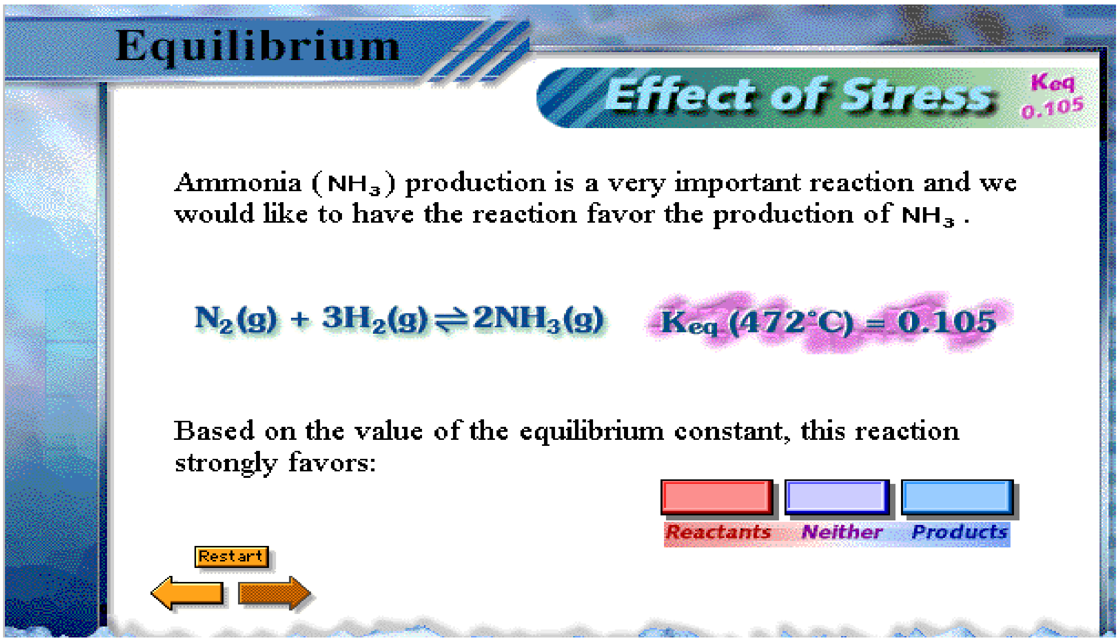

fig. 5. A screen presenting a sequence for learning the topic "Le Chatelier's Principle"[3]

The screen in figure 5 shows a learning sequence in which symbolic representation of information is presented. Intuitive and inductive learners can prefer this. The presentation of information begins with symbolization of a particular case of equilibrium processes, the interpretation of the phenomena then proceeds with generalization. The process is represented at the symbolic level-through equation of reaction and numeric data. The learner is involved in an active process of assimilation this sequence of information. He/she has to solve a problem and further has to construct his/her own knowledge.

Conclusions

It is well known that the use of computers in chemical instruction falls into two distinct categories. First, computers can assist the educational process, helping to educate new chemists. Computers can be used in order to enhance teaching process, to enable students to learn better and/or faster, to save time and/or money. The second category deals with the computer knowledge students need to acquire to be effective practicing chemists. These are skills and tools that will serve the chemist in almost every type of jobs.

This paper refers to the first application of computers in the educational process. Because learning is an individual experience for each person, the use of computers has to take care of this. There was described how computer instructional materials are tailorable for different learning styles, when they are well designed. Using materials where different learning styles are included, the learning process is enhanced. The use of computers not only facilitates learning and built skills, but also leads to increased enthusiasm for school, independent study cooperative and constructive learning.

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