

How to generate a near infrared knowledge base—a multimedia tool for teaching and learning

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Introduction

Near infrared (NIR) spectroscopy is of growing importance. More and more analytical problems are to be solved by the use of this powerful analytical method which stands out for fastness, lack of sample preparation and saving of resources. In qualitative and quantitative applications the precision of results comes near to that of conventional analytical methods which often are used as reference methods.

Despite the very high benefits provided by NIR spectroscopy there is little knowledge about it, especially, when compared to other spectroscopic methods such as mid-infrared spectroscopy or UV/vis spectroscopy. There is still some scepticism among chemists mainly concerning chemometric interpretation of NIR spectra. Many students who have finished university have not heard anything about NIR spectroscopy during their education. When later in their jobs they are responsible for the introduction of new analytical technologies, these specialists may need a lot of time to get acquainted with NIR spectroscopy.

Thus, it is important to create a broad NIR knowledge base. Our target was to give our customers a tool to be used either in an accompanying or a repetitive way in relation to our NIR training courses. We chose modern media to communicate our message about NIR spectroscopy. An *interactive multimedia* computer software seemed to be the up-to-date answer.

Multimedia technology is the result of the combination of the computer and consumer electronics. This combination increases the functionality of the computer. With multimedia the computer can process text, graphics, animation, simulations, stillvideo, video and sound.

Interactivity is the opportunity to guide the program in an individual way and to get a qualified feedback from it. The user guides the speed and direction of the program either with the mouse or the keyboard. The program gives feedback and helps the user to understand. With interactive learning software you have an individualising tool.

The concept

The Buhler multimedia learning software NIRTEACH—a Windows based program—was developed in cooperation with the education department of the University St Gallen. It was created with regard to the newest pedagogic criteria.

Our learning and presentation software is programmed as an instructional design. It is easy to use, even for persons who are not computer trained. The learner has different interaction strategies to meet his personal goals. These interaction strategies guarantee that users will not get lost in the software. *Program control* is most effective for novice users. According to their needs this software has seven strategies. Advanced or expert users can use the *learner control* features.

Program control

If users wish to be guided by the program, they must choose one of the possible strategies or learning paths. The selection of the defined learning path is performed at the beginning of each lesson as is shown in Figure 1.

- “Obtaining overview” only offers an overview of the learning goals and the subject matter.
- “Getting familiar” provides an overview and then explains the subject matter.
- “Knowing fundamentals” allows the user to do a few small exercises in addition to being given the overview and explanations.
- With “Mastering knowledge” one passes in time through the overview, development, exercises and learning check sections, i.e. the entire program.
- Under “Test-Correct” users first start with the learning check before they continue with overview, development and exercises.
- “Test-Correct-Test” is the same as the “Test-Correct” strategy, but at the end the learning checks are performed a second time.
- If you only want to check your knowledge, you can limit yourself to the learning check with “Rate-Assess”.

If one of these strategies is selected, you will be guided by the program. The *navigator* shows the sequence of the phases. The program sequence is indicated by a chain of arrows.

Learner control

In the learner control mode users have the opportunity to move freely around the program by clicking “Self Control”. This learner control feature lets them move very quickly from one point to any other within this program.

The lessons have a systematic didactic design to allow for easy navigation:

- Overview
- Developing the knowledge

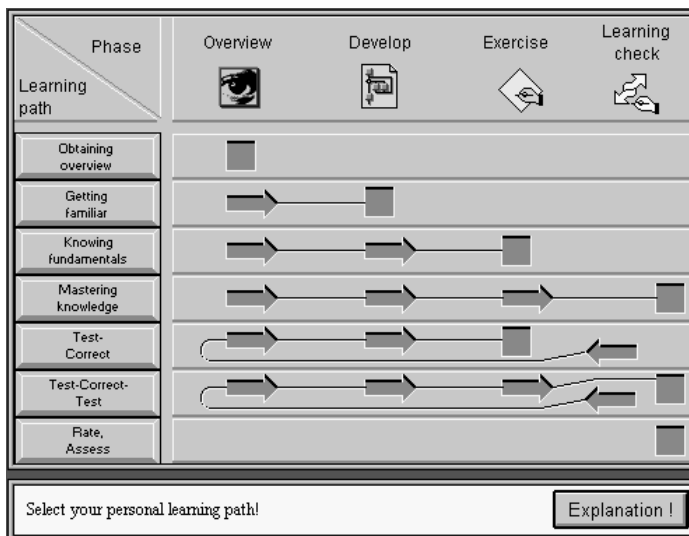


Figure 1. Selection of the learning path.

- Exercises (practice)
- Learning check (testing).

With developing the knowledge learners can build up their own knowledge structure according to their personal interaction strategy. The practice section offers a lot of opportunities to train. In the testing section users can check their knowledge. They will receive qualitative feedback to improve the learning process.

In order to switch from one phase to another the navigator is needed. It appears after having pressed the self control button. In Figure 2 it is demonstrated how to go from the navigator to your individually selected learning phase.

The contents

Lesson 1: Follow the path of the light

In the first lesson users can follow the light path and will meet the components of the Buhler FT-NIR spectrometer, NIRVIS. In addition, they understand the functionality of these components. The software will develop the knowledge together with its users. In a first round the system offers them all details step-by-step. So they will gain a systematic overview. In the second round the knowledge base can be explored according to your own priority. Pictures of the major components will help the user to imagine how things look and how they work.

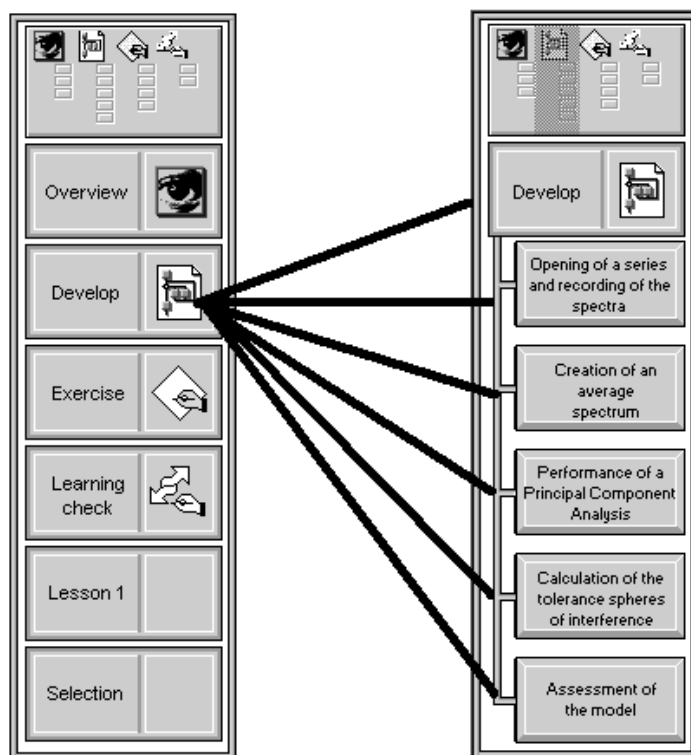


Figure 2. The navigator connects on the one hand phases in the learning process and on the other hand contents of learning by individual handling.

Lesson 2: Simulation of the chemometric software

Amongst others, chemometric software has the following functionalities:

- to control the spectrometer;
- to process the output of the spectrometer;
- statistical transformation of these data;
- to form the application model;
- to process macroprograms.

Normally the user does not see the statistical operations. For daily work this is a considerable advantage. But for the understanding of the quality of an application or the relations within a given application it is useful to have a basic knowledge about the hidden statistical processes. It is important to follow the major statistical steps. This software visualises statistical explications parallel to the development of an application. The didactic explanation of relations is one of the advantages of such a learning environment. Together with the learner control features, you can explore some of the difficult chunks of chemometric knowledge.

The Buhler FT-NIR universal spectrometer, NIRVIS, is driven by the chemometric software BCAP. This multimedia learning and presentation software provides simulation of the basic functions of BCAP. Users can learn how to handle the chemometric software without the original software. You can learn the contents step-by-step and you get system feedback to improve the learning process.

A basic problem in the learning process is the imagination of parameters. The interactive multimedia learning software visualises the central steps with simulations and animations. With this tool you can prepare a beginner of NIRVIS and BCAP for his work in an ideal and simple way. With the learner control navigation section you have a very handy presentation system.

Experiences

Within one year of its existence, the multimedia learning and teaching software NIRTEACH has found its use in different areas:

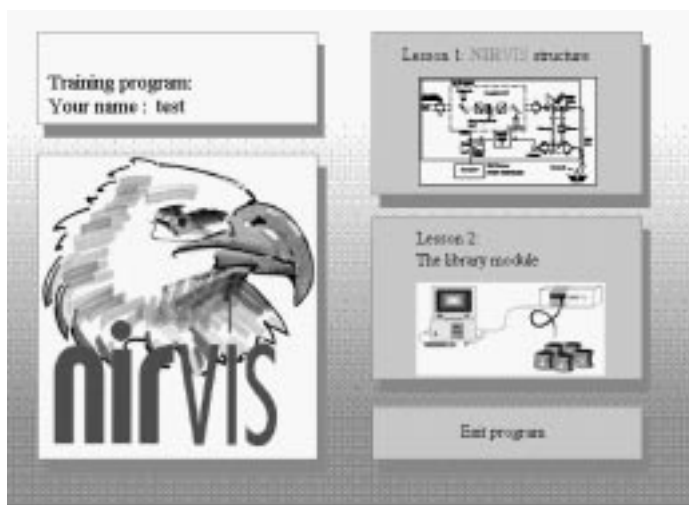


Figure 3. Overview on the contents of NIRTEACH.

- At the customers site as a repetitive and complementary tool to the NIR training courses, as well as for the instruction of further coworkers to NIR technology.
- At the distributors site as a representation tool as well as a training tool.
- At universities and technical colleges for integration in the education of chemistry students according to individual needs (place and time to learn, learning velocity).

The resonance of users is mainly positive. In the following a few advantages commonly mentioned are listed:

- dynamic correlations
- information represented in different ways
- individual learning speed
- individual learning path
- combination of system- and user-control
- explanation and visualisation of complex connections between optics, mechanics and electronics, statistics and computer science.
- runs on each PC
- simple navigation
- low costs.

NIRTEACH provides high flexibility and individualism for teaching and learning. It makes a contribution to reach a broad base of knowledge about near infrared spectroscopy. As a multimedia tool it has possibilities for the extension of further aspects of NIR spectroscopy and chemometrics.