The Relevance of Haptic Experience in Remote Experiments

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Abstract: Experiments are an important part in technical education to improve understanding of the theoretical content. In the last years efforts have been made to provide access to real experiments via Internet (Aktan et al. 1996; Wagner et al. 2001). Unanswered is the question on the effects of learning outcomes, the problem solving process, the, acceptance and the motivation of these non haptic experiments with their reduced focus of real world experience.
In this paper we describe the didactic concept of our remote lab and the evaluation framework for an empirical study which aims at examining the effects of the haptic component on problem based learning in remote laboratories.

The Remote Experiment

In our remote experiment for learners of process control at technical schools the learners have to develop and upgrade a program for an industrial controller (PLC) that controls a process engineering plant. In this process a fluid can be filled into the two tanks and heated or mixed in the reactor below.

The learners process the reaction of their program on the process through a remote controlled web cam. To access the lab devices the learners only have to run a web browser.

Didactic concept and task structure

The didactic concept in our remote lab course is orientated on problem based learning (see Norman 1991). The experiment is done in small groups of two or three learners. They are guided through the experiment and get additional information from a web based course. The course is structured in two parts. The first part is divided intro three subtasks with increasing aspiration level. The second part is a thematic structured knowledge base of the content for explorative learning. Designed as a guided tour through the subject matters we address three different types of learners. The practically inclined learner may start with an example, the analytically inclined one with a description of the structure of a PLC-program. Learners who already have gained experience with PLC program development may choose the third, the quick path being offered.

In the beginning of the experiment the learners have to find an error in a controller program (*remote diagnostic task*). They have to read the data sheets of the actors and sensors in the system and understand their relation to the given program. They have to correct the program, upload it to the controller and examine the function of their solution at the plant by using the web cam *(remote maintenance task*). During their next steps they have to upgrade the program and include functions additional for a local operation unit (see figure 1) and a “notification of fault” function.

Evaluation Approach

To evaluate the relevance of the haptic experiences in our experiment we made a comparative approach, where the learners execute the experiment in three different settings (see table 1).

Setting	Description
Local learning setting	The conventional learning setting, where the learners and the experiment are in one room.
Remote learning setting	The group of learners are separate from the experiment.
Distributed learning setting	The learners are distributed and collaborating by synchronic tools like chat or video conferencing.

Table 1: Variation of the learning environment

All groups have the same devices (for the local group they were 'real', in the other two setting they were 'virtual' for the groups) and the same lab exercises. But only in the local learning setting the students had the full sense of impression of the lab devices and of the other learners.

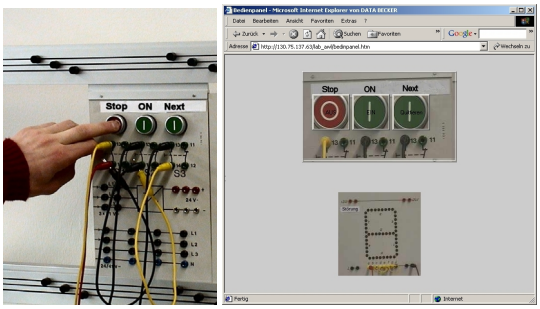

Figure 1: Local operating unit and Virtual operating unit

Evaluation Methods and Data Acquisition

Our three different learning settings have one evaluative question in common: How far does a loss in haptic experience effect the outcomes of the learning process to be achieved?

To measure the increase in knowledge we will carry out short pre- and post tests. To evaluate the quality of the problem solving process, we will observe the learners' activities during the experiment by means of a self developed evaluation tool that enables the evaluator to write down the activities of each learners' group into a database. Additionally, we will analyze the server log data by another self developed tool to trace information about the ways a group of learners took through the web based course and for how long they stayed in each chapter. At the end of the lab exercise all learners will have to answer a questionnaire gaining subjective information about their acceptance and motivation during the experiment.

The collected data will give us the possibility to compare the outcome of the learning process, the structure of the problem solving process as well as the acceptance and motivation in the three setting.

Conclusion

Setting up remote experiments raises many questions in the field of education. One of the main question is: How the loss of haptic impression change the learning effect. Special areas of interest are the acceptance, motivation, learning outcomes and quality of the problem solving process. Currently we are acquiring data in three classes with about 75 learners in vocational schools. Our aim is to find out if Remote Labs are a suitable way for problem based learning compared to traditional experiment settings.

References

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