

### 3.2 Computer Technology as a Medium in Teaching and Learning

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We understand media as things that are used as signs by human beings. With this broad term of media it is clear, that media need to be applied in all educational processes. This starts from the body in the medium of a gesture and reaches through oral communication to technical appliances like books, TVs or a computer.

From the different aspects of our media theory we would like to highlight one aspect here: Technical media are artefacts, and human beings express themselves in these artefacts. This describes a layer of communication, where the material of a medium is shaped in order to exchange ideas. This layer of communication has been highlighted by the Toronto School [48, 64]. Since using material in a medium is necessary for communication, this layer affects educational processes. In educational processes, it is impossible to avoid the bias of communication caused by the material layer, but necessary to choose or, if it comes to technical media, shape the material layer of the medium used.

Here, it is not possible to discuss criteria (like the interest in acceleration, individualization etc.) for choosing or rejecting computer technology as a medium in educational processes. We just assume as obvious that it is possible to teach and learn with computer technology and describe the material layer of computer technology in order to inform the design of our tools.

Computers today are nearly always build as electrical universal Turing machines with a von Neumann architecture. This design of the material layer of the medium leads to a set of properties. One important property is, that computers need to be programmed. Programming a computer is quite different from educational processes among human beings. The program determines the output of the computer, even if stochastic measures are used. That's why transferring information between computers has a very different meaning than learning in the field of education, as we already stated. We would like to add three observations to take a closer look at computer technology here.

The first observation is, that the memory of human beings and the data storage of computer technology are quite different. Human beings can't forget. Of course, human beings do forget. But this is something that happens to human beings. It is not a competence. There is no "mastery of forgetting". To the contrary: The harder humans try to forget something, the better they

remember it. Deleting data with computer technology is quite different: It can be executed on purpose. And it can be done sustainably.

The second observation is, that there is an exact alignment among assembler commands and machine code in digital electric Turing machines. Since the meaning of machine codes in actuality is the physical reality of the actual machine, there is no difference between symbols and reality for computer technology [58]. As René Magritte has illustrated with the words "Ceci n'est pas une pipe" on his famous picture "La trahison des images" [The Treachery of Images], this is not the case for human beings. For people, the relation of symbols and reality is problematic - to say the least. That's one reason why human beings become problems for themselves. Fortunately, this is not the case with computer technology.

These observations illustrate that the term "learning" signifies different concepts in computer technology and in education. The difference between these homonyms is the challenge when it comes to modeling didactic expertise with computer technology. With this challenge it is clear, that trying to replace teachers by computer technology is not an option. Machine learning and human learning can not be converted, there is no jumper to close the open gap. That's why we consider computer technology as a valuable tool that can be used to design an Adaptive Assistant System for teaching and learning. From the media didactic point of view, the challenge is to create applicable algorithms and thus design the material substance that is used in the medium. Until now, we tried to elaborate some limits of the application of computer technology in education. With this in mind, we are going to discuss the history of Adaptive Assistant System in the next section.

## 6.4 Conclusion

We have defined four universal criteria a learning environment has to satisfy to be adaptive with respect to learning style, behavior and preferences of individual learners. Firstly, Didactic Factors have to be retrieved by measuring correlated indicators. Secondly, these factors have to be transformed into a machine-processable form. Thirdly, the Didactic Factors have to be annotated to learning content, together with didactic relations between pieces of learning content. Fourthly, the learning environment deduces the according instructional design from this formal representation.

INTUITEL satisfies the second, third and fourth of these requirements. With the Hypercube Database project we aim to close the gap to the first requirement, designing and developing a research tool for the analysis of learning histories. We model learning histories as spatio-temporal trajectories treating the time dimension as an immanent part of learning. Besides the learning content itself, the concept of the advanced hypercube also includes arbitrary additional data that may result from measured indicators. By this — inside the space of the advanced hypercube — data is lifted to a highly abstract level, mapped to purely geometric information.

This leads to a compact representation allowing us to analyze a wide range of data solely on the grounds of hyperpolylines, their spatio-temporal characteristics and their relations to each other. Not only is this a new application of a spatio-temporal database. It also offers a new approach for finding common learning pathways and Didactic Factors correlating with them. By this, we can predict learning pathways by observing a learners' current actions and retrieving the according Didactic Factors, which constitutes the enhancement of adaptive learning environments in the future.

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