User-Modelling and Adaptivity in Therapeutic Intervention Environments

Michael Pieper, Henrike Gappa
GMD – German National Research Center for Information Technology
Schloss Birlinghoven
D-53754 Sankt Augustin
+49 2241 14 - {2018, 2793}
{michael.pieper,henrike.gappa}@gmd.de

ABSTRACT
Even though computer interfaces for handicapped and elderly people have already been investigated for quite some time, this research primarily dealt with adaptations compensating for functional impairments on the lexical (I/O) level of user interface design. In this position paper, we present a user-model based system environment featuring personalised semantic adaptations for the training of metacognitive skills of a developmentally delayed 12 years old child..

Keywords
Assistive Technology, Personalised User Interfaces, User Interface Adaptivity and Adaptation

INTRODUCTION
The case study involved a 12-year old severely handicapped child. He is effected by brain deficiencies aquired in early childhood and exhibits behaviour as described for autism. So far, he was unable to use computer-assisted training materials due to attention deficits, a lack of learned problem-solving strategies and further perceptual disorders. The child has immense difficulties to distiguish between relevant and irrelevant stimuli in learning-situations. Normally he reacts to the most intense stimulus with non-reflected impulsive response.

Given these circumstances the child was regarded as hardly being educationally advisable Thus, the question arised, whether computer-supported learning environments could ease this process of educational advise. Corresponding trials however showed, that commercially available learning software could rarely contribute anything to that purpose. The child simply could not follow the broadly accepted didactical approach of problem-oriented incremental learning being prevalent in most of commercial learning software.

Therefore, in a first step, a special intervention module was integrated into some kind of a computer-assisted memory game for the training of metacognitive skills featuring various individualised adaptations to compensate for the child's cognitive deficiencies.

The conceptual model underlying the software arcitecture of that system was derived from the "Unversal Design for Learning" approach propagated by CAST (Center for Assistive Technologies). Central to this approach is to implement so called *Scaffolding* techniques into the system. In it's broadest meaning Scaffolding relates to supportive measures of any kind, reaching from cut curbs for wheelchair drivers to human mentoring mediating cognitive and behavioural aspects of problem-solving nin learning environments. In fact the intervention module of our system can be characterised as a virtual mentor who supports the child in giving hints about what to reconcile (cognitive aspects) or enact (bahavioural aspects) to solve a given problem..

To sustainably maintain a sufficient degree of attention of the child was the main conceptual problem we had to overcome in designing and implementing the intervention module. We assumed to be able to get to grips with this problem by modelling a so called "Socially Significant Other" as the virtual mentor of the intervention module. Social Psychology refers to "Socially Significant Others" as a person who – by being attributed with certain socially significant characteristics - gains and exerts influence over other individuals. Socially significant characteristics like sympathy, competence and low social distance, which allow the child to impress the virtually intervening mentor, turned out to be most important in our case study.

THE SYSTEM AND ITS USAGE
The memory game as it is implemented now offers two modes. In the first mode up to 8 picture cards are shown on a computer screen presenting only one pair of animals. All the other picture cards show different animals. This is a discrimination task geared at conveying the concept of

”the same“, since this is the underlying concept of a memory game.

During the whole problem solving process, the developed software evaluates all given input (dynamic user protocol module) by matching it with the predefined model (static user model) of a correctly playing user. If mismatches are discovered the intervention module is triggered. Depending on the kind of mismatches it intervenes, based on an accordingly specified rules (adaptation module), by verbalizing the required behavioural and/or cognitive aspect, e.g. requests like: “Take a close look…“ (behavioural aspect), “Compare all animal pictures one by one…“ (cognitive strategy). In case the response was correct, a short sound-track including, for example, how this animal “calls“ for other group members is presented. If verbal intervention does not lead to a successful response, a comic figure (a magician called “Mirko“) is shown on the computer screen prompting the correct reponse by “sitting next“ to the picture card looked for. After a certain amount of correct responses, a reward is implemented by a comic figure looking like a little boy dancing on stage according to the favourite songs of the child.

The second mode of the memory game presents up to 4 pairs of picture cards with animals. At first all animals on the picture cards are shown. After about 5 seconds, all picture cards are covered and the child is asked to remind where he has seen animals that look the same. The intervention and reward strategy was selected according to the first mode of the game.

RESULTS

In course of the training, each session is recorded by a short questionnaire rating achievement motivation, degree of independency while working and the like. Furthermore, a log file recording all clicks on the touchscreen was installed.

Good achievement motivation

Evaluation of the log files and the questionnaires representing the first three months of training proved, that the child shows good achievement motivation and very much interest in working with the socially significant person via the computer. He was able to solve all given tasks requiring more or less intervention depending on the level of difficulty of the game.

No further decrease in intervention

Moreover, it was observed that after about two months of training, the amount of intervention needed did not decrease further, although the child obviously was able to solve the tasks correctly. Evaluation of the position of each mouse click indicated, that the child has strong preferences in clicking on specific locations on the screen without reflecting upon the correctness of the given input.

Attention refocussing by intervening prompts

When prompted to reflect upon the given input, the correct response was given immediately. This behaviour is not to explain by the physical impairment of the child but rather by the perceptional deficits influencing all information processing procedures. They are causing difficulties in detecting the relevant stimuli of a given task as well as the rigid holding on to familiar behaviour patterns demanding for constant attention refocussing.

DISCUSSION AND CONCLUSION

Since the presented investigations are conducted as a case study, results are not to generalize. However, the investigations gave evidence that adaptations on the semantic layer of software are successful in fostering therapeutic processes. In the ;.case study described, multimedia technology was used for implementing a socially significant person facilitating the acquisition of metacognitive skills enabling a child with a prevailing attention deficit disorder to learn how to play a memory game. Furthermore, perceptional deficits causing incorrect responses could be compensated for by immediate attention refocussing. The concepts introduced are now investigated further by designing a computer-assisted learning environment for acquiring reading skills.

REFERENCES

1. BACKMANN, C. W. (1974): Social Psychology. New York, N.Y.: McGraw-Hill,
2. BATSHAW, M.L. & PERRET, Y.M. (1992): Children with Disabilities: A Medical Primer (Third Edition). London: Brookes
3. DAVIDSON, E.; DEUSER, R.J. & STERNBERG, R:J: (1994): The Role of Metacognition in Problem Solving. In: METCALF, J. & SHIMAMURA, A.P. (eds.): Metacognition. Knowing About Knowing. Cambridge: MIT Press
4. Stephanidis, C. (ed.). User Interfaces for All - Concepts, Methods, Tools, Lawrence Erlbaum Ass. Inc (Mahwah - New York – London) 2001
5. GAPPA, Henrike; PIEPER, Michael and MERMET, Stefanie: Potentials of Multimedia Applications in Therapeutic Settings Serving Developmentally Delayed Children,m in: VOLLMAR, R.; WAGNER, R. (Eds.), Proceedings of the 7th International Conference on Computers Helping People with Special Needs (Karlsruhe,Germany), pp. 221- 228. Österreichische Computer Gesellschaft (Wien, July 2000, ISBN 3-85403-145-9).