EVERYTHING VIRTUAL - VIRTUAL CLASSES, VIRTUAL TUTORS, VIRTUAL STUDENTS, VIRTUAL EMOTIONS - BUT THE KNOWLEDGE

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ABSTRACT

The paper illustrates a selection of interesting aspects of adaptation and personalisation in the context of face-to-face classes compared to computer-based classes. It gives an overview on features of on-line learning systems that facilitate the learning process in particular within the Web. Interesting insights based on experiences in our research work and prototype implementations in the field of intelligent tutor systems are outlined. An outlook on possible future developments of adaptable systems and innovative teaching and learning approaches is provided.

KEY WORDS

Adaptive e-learning, teaching and learning strategies, human computer interaction

1. TEACHING AND ADAPTATION PROCESSES IN THE REAL WORLD

Hence the majority of teaching has been carried out in face-to-face lectures or tries to replicate this method in the virtual world, we will start considering personalisation and adaptation (P&A) in computer-based or computer-aided learning by moving back and presenting the same mechanisms in a classical, i.e. in a face-to-face learning situation. We will then move to the virtual world. We will explore the possibilities provided by technology that support individual interactions with knowledge that reach far beyond the possibilities provided within face-to-face lectures, thus bringing innovative concepts into the field of learning.

In the situation of a classical lecture or seminar, adaptation and personalisation can take place as well. It means that the teacher adapts his or her way of teaching or adapts the content, based on feedback received by the students. According to [Picard 1997], the way of thinking of adults can be described as a combination of "assimilation" and "adaptation", where assimilation means to use well-known insights in a relatively effortless way, whereas adaptation means to create new insights based on new circumstances by logical thinking, which costs more effort.

In the classical situation there are two possibilities for this feedback to be provided: explicit feedback and implicit feedback. Explicit feedback means that the students communicate to the teacher what they have understood from the learning content, what other content they would like to know, what other kind of teaching they would like to have. This is sometimes given during the lecture or seminar, maybe on request by the teacher, based on a pre-test, or during an exam, or it happens by filling out a dedicated feedback form, often also in an informal talk. Implicit feedback is information that the teacher receives from the students via non-verbal signals during or after the lecture or seminar, such as noise level or nodding with the head.

In the design of e-learning solutions it may be difficult to determine the right degree of personalisation and adaptation (P&A). Preliminary estimations on the effectiveness of human-computer communication can be made if we take human-to-human communication as a starting point. So we postulate that *"the degree of P&A desired or accepted by the users (students) will be close to the degree of P&A offered to students by*

an experienced and successful human teacher". What we mean by adaptation in a face-to-face teaching situation is basically the sum of all reactions of the teacher on the explicit and implicit feedback that he or she receives. The range of human adaptation is as broad as the range of human personality, however limited by several factors.

Let us classify the adaptation of a human teacher based on student feedback in short term, medium and long term loops. *Short term adaptation* happens within the same lecture unit or seminar unit in which the feedback happens. When receiving negative feedback, a teacher first may repeat content more slowly or in other words, or add an example that illustrates the content. A *medium term adaptation* loop happens in time frames longer than one seminar unit but shorter than the whole lecture or seminar (usually from a few days or weeks up to four months). When receiving negative feedback, a teacher may adapt the content of the next seminar unit by repeating content, inserting examples or showing audiovisual material. *Long term adaptation* happens when a teacher modifies the content or didactical approach of the whole lecture or seminar according to feedback based on the previous seminar. Measures may range from adaptation in teaching speed, giving examples and other measures mentioned above, and go up to a complete change of the didactical approach on which the lecture is based. Long term adaptation of lectures has resulted in the creation of new approaches like problem-based learning or "Mengenlehre".

According to our postulate an ideal computer-based training (CBT) resource would offer adaptation of *the same degree and quality as human teachers do*. While the CBT features initially may not have the same behaviour as humans due to the known limitations of artificial intelligence, the adaptation offered by humans should always be the example and define the limitations for desired CBT features.

Having said this, is it astonishing to add that human teachers offer a very limited range of *personalisation*? If according to our postulate the ideal learning situation is state-of-the-art content illustrated by real-life situations and moderated by a skilled human teacher, the basic personalisation features of the human-to-human learning situation are the following: Students have the opportunity to communicate with the teacher and with other students and discuss the content. Furthermore students may take notes, sketches, photocopies, photographs, video and audio recordings, use books and create their own sets of data consisting of the said artefacts.

In analogy to the human example and besides the collection of implicit and explicit feedback leading to adaptation, the desired personalisation features of an e-learning resource include at least a student-to-student communication facility and the possibility to collect personalised content in form of notes, sketches, photocopies, photographs, video and audio recordings, and books or rather e-books. These features are of course to be enhanced by the opportunities of the digital age like the possibility of viewing remote e-books, data bases, or remotely ordering books from diverse libraries, communication with remote teachers or students, and self-testing by the student at any time.

2. SUPPORTING THE TEACHING AND ADAPTATION PROCESSES WITHIN THE VIRTUAL WORLD

From the didactical point of view there are numerous approaches to learning, such as learning by observation, learning by enquiry and investigation, learning by doing, individually, face-to-face and in groups, experimental learning, learning by evaluation and reflection. As outlined in [Buckley 1999], learning environments that exploit interactive multimedia are of special interest. The educational potential of this technology closely parallels the pedagogical goals of the Learning Paradigm. According to [Buckley 1999] a simple pedagogical set of features that can foster transition to the Learning Paradigm is as follows: (1) Interactivity fosters active learning, (2) The sensory-rich nature of technology facilitates the engagement of additional powerful cognitive processes, and (3) Integration of assessment tools into the environment can provide students with feedback, encouragement etc.

In the field of Web based training, learning is much more than reading lessons by navigating through prepared multimedia courses and working out exercises. Further elements like communication, collaboration, dynamic and static background libraries and using a search engine on the Internet and exploring material on WWW sites are needed [Lennon 1994, Maurer 1999, Dietinger 1999]. E-learning also has to support “life long learning”, “goal oriented learning”, “learning on demand” [Gütl 1999, Dietinger 1999] as well as various kinds of formal and informal education. Additional challenges to e-learning come from econ-

omy, science and management where the quick and full access to information - the information advantage - is also a quality and competitive factor.

What is adaptation and what are adaptable systems? How do we experience those systems from the user's perspective, i.e. from the usability point of view? When we evaluate a product according to the principles of usability, we apply the usability evaluation principles that are based on the ISO DIS 9241-11 standard and also described e.g. in [Jordan 1998]: "Usability of a product is defined as a combination of three separate aspects: effectiveness, efficiency and satisfaction. Effectiveness means the extent to which the user's goal, or task, is achieved. Efficiency means the amount of effort that the user requires to accomplish a goal or achieve a task. Satisfaction is the level of comfort that the user feels when using a product and how acceptable the product is to users as a vehicle for achieving their goals."

Let us have a look at a research area of adaptive hypermedia systems (AHS) that is merging the fields of hypermedia, adaptive systems and intelligent tutoring systems. The aim of AHS is to increase the functionality of hypermedia and can also ~~to~~ improve the learning process. AHS can be applied for educational purposes in the form of adapting the presented information to the current knowledge level of the student, providing navigation support on various levels and guiding the student in the learning process [Beaumont 1995]. One of the main features is the adaptation ability based on user preferences and the knowledge level of the user [Hockemeyer 1997]. At the same time, another component of AHS are Hypermedia Systems. Hypermedia Systems can be also applied as explorative systems that should facilitate the learners to find the information needed. In almost unstructured information space this task often proves to be too complicated and very time consuming for the learner. AHS try to resolve this problem based on adaptable communication with the user.

There are various technical solutions of adaptable systems. *Shadowing* is a very simple approach where irrelevant links and material for a specific user are dimmed [Hothi 1998]. Though the material is accessible to the user it is clearly demonstrated, that the material is not appropriate. Much more restrictive is the solution of *hiding links* or not allowing the user to access the visible but inappropriate material [Brusilovsky 1998]. This approach could lead to frustration of the user. Another interesting solution is called *stretchtext* and is applied in the MetaDoc system [Boyle 1998]. When a stretch link is activated the original text is expanded with additional material. With deactivation of the link the text shrinks to the prior format. However, the temptation of following various links offered remains whereas the probability to lose the focus on the learning context arises. Interesting concepts of adaptable knowledge presentation e.g. adaptable book concept called Multibook and an application of the concept MediBook that support life long learning are described in [Seeberg 2003].

We would like to point out that the challenge of next generation adaptable e-learning systems lies in providing innovative and generally applicable new approaches to e-learning, based on interface and content adaptation to the user knowledge and performance. The adaptation can be based on the age of the user, preferences, user overall performance and can result in a user interface with reduced number of features or in contents presented on different ways, among others. Such adaptable e-learning systems can support a broad spectrum of different user groups as well as different ways of learning. Therefore, the systems can be applied for children education, corporate education and life-long learning. The adaptation, content granulation and system interoperability can be carried out with help of the international e-learning standards from the standardisation groups and committees as follows: SCORM, IMS, IEEE LTSC, ISO SC36, etc.

Based on the insights stated so far, we propose the Eye-Tracking Supported E-Learning environment. It represents a new and innovative approach to adaptive e-learning methods. Basically, the idea is to introduce an improved, real-time-capable eye-tracking procedure for intelligent user profile deduction on the one hand, and the use of a dynamic background library on the other hand. By means of eye-tracking, the behaviour of the learner is recorded in real-time and used for adaptive knowledge transfer. This information produces among others detailed user profiles through more targeted identification of the actually consumed knowledge units. The dynamic background library provides further information to the learning units, corresponding to the needs and knowledge of the learner. Different user interface approaches to adaptive knowledge transfer will also be developed and evaluated. The presented novel idea is a joint research effort of FH JOANNEUM University of Applied Sciences and the Institute for Information processing and Computer supported new Media, Graz University of Technology. [ETLEARN 2003]

2.1 One Step Ahead

As we know, every artefact, especially computers and even more so agents are subject to "anthropomorphisation" by the user. This means the user - to a certain extent - treats the machine like a human being. This is an argument for providing features to virtual teaching agents that are similar to the capabilities and "features" of human teachers. Especially the guiding role that can be found even in the most participative teaching styles, should be preserved for virtual teachers. An expert system named Virtual Tutor (VT) was developed as an interactive multimedia knowledge module with explanation features [Gütl 2002, Gütl 2003]. This application merges qualities of an expert system with advantages of multimedia, thus creating a variety of innovative ways of knowledge mediation. For students, the individual dialogue based session with the VT provides the possibility to apply the knowledge acquired in combination with indirect assessment. The VT was further embedded in the Web-based on-line learning environment. As already mentioned in the previous chapter, there are many benefits for students within the on-line learning environment independent from course content and style, like e.g. tools for asynchronous and synchronous communication and collaboration, search facility within a background library, a progress indicator monitoring the learning success etc. In addition, the application of expert systems makes it possible to use a different knowledge representation and explanation approach. The individual VT session also provides the possibility for students to apply the knowledge acquired in combination with indirect assessment. With interactive VT sessions, various students' activities could be enhanced as follows: raising the learning motivation, research work, stimulating the creativity by carrying out analysis and synthesis, searching for solutions, interdisciplinary learning. Interaction with the VT could be seen similar to a personal dialogue between student and teacher.

An complementary but also interesting work in the field of research is the Virtual Student Clone (VSC), which is also based on our research results. The running prototype is developed at the Institute for Information processing and Computer supported new Media (IICM), Graz University of Technology. The VSC is based on the idea "the best way to learn is to teach". Based on this hypothesis, the basic idea is as follows: a student has to teach the Virtual Student Clone particular topics concerning selected subjects of the course. As a part of the course evaluation, the Virtual student clone will be examined by the tutor or the teacher. The first prototype exploits the web-enabled knowledge-based artificial intelligence system Alicebot by implementing the AIML knowledge bases [ALICEBOT]. The Alicebot system is a web-based chatterbot, which can be used for a dialog-based online examination by tutors and teachers. From the AI point of view, basic elements like simple dialog and communication skills are already available as open source, which have been adapted for the specific requirements. In addition a teaching interface allows students to train their virtual student clones by implementing rule-based knowledge of particular subjects. From the e-learning point of view, students have to train their virtual student clone by implementing rule-based knowledge and examine the learning process of the clone. In the process of training and examination, students can get new insights of the subject domain knowledge. The virtual student clone will be introduced in the course "information search and retrieval" at the Graz University of Technology and a thorough survey will be carried out. The overall vision is that the virtual student clone will become a virtual student fellow over a longer period of time. Students should train and teach the virtual student clone all the topics they have to learn. Instead of the students, the virtual student clone will pass and fail examinations. Besides that, the virtual student clone can save and preserve a lot of knowledge, providing access to this knowledge in form of answering questions of the real student fellow.

Already early experiments like ELIZA [Weizenbaum 1966] showed that people react emotionally to computers and also expect human behaviour from the machines. Recently various applications, like virtual tutors "Liza and Lili" [Bruns 2003], have been developed that try to demonstrate emotions and also behave or respond emotionally. Liza is able to provide appropriate reactions on the user's emotional signals. Computer scientists and social scientists research various applications and possible scenarios of Computer-Supported Co-operative Work (CSCW). Key questions of the research are: How do virtual environments influence the relationship between users, appearances in the virtual world and their influence on various interactions? What governs the formation of virtual communities? How strong the emotional involvement in the virtual world can be?

Recent research has shown that emotions are important for learning [Spitzer 2002]. Spitzer states that people memorise details, things and events that are related to the "better than expected" sensation. In her book "Affective Computing" [Picard 1997] discusses emotions and computers and reflects upon building affective systems. Already at present computers are able to recognise several facial expressions and distinguish different vocal expressions. Research results of Picard's team showed that with a success rate of about

81% eight emotional states can be recognized. The technology also enables gathering of physiological signals and monitoring behavioural patterns of humans. One question of concern with any new technology is "How will it impact people?" [Picard 1997] Similar to adaptation regarding to learning styles, it could be the classification of users regarding their emotional type, thus providing the adapted learning contents and interface with information about the personal emotional state of the user.

In his book "The Inmates are Running the Asylum", [Cooper 1999] introduced the notion of personas to HCI. Originally a persona is a virtual person appearing in a theatre play or in a movie. When designing a UI, Alan Cooper suggests defining user personas, i.e. virtual persons who represent typical, average people belonging to the product's target group(s). Information about the target groups is collected before the persona definition via interviews, focus groups, etc. One persona is selected who for some reason is the less skilled one because of age, knowledge or experience. This persona will play the user's role in the UI design process. It is for him or her that the User Interface is designed. The reason for using personas and not real users in the design process is primarily that a persona does not have individual needs or properties that every real person has. The persona only has collective, average properties and needs instead. Also the persona is always available and after a while will be well-known by the designers and engineers.

At their i-Know '03 paper presentation, Pivec and Baumann transferred the idea of personas to e-learning [Pivec 2003]. In the real world university students usually can select their teachers. In today's e-learning tools, the tool may try to adapt to the student, or the student can set various parameters in order to personalise the tool. The persona concept will make this choice as easy as in an ideal real world situation: Students can select one out of a set of teacher personas that represent various tested and approved teaching and learning styles. This leads both to better usability and to quicker and higher quality adaptation than the other known methods.

Figure 1 shows examples of teacher personas developed in K. Baumann's seminar at FH Joanneum's department of Information Design. The rough description of the personas is as follows: Hans, mathematics teacher, 47 years old, casual smoker, relaxed attitude when teaching, prefers visual approach of explanation, examples taken from real-world situations; marital status: divorced, one child; driver of a convertible sports car; favourites: the Rolling Stones, sailing, holidays in Greece. Mary, biology teacher, 38 years old, well-structured approach to teaching, prefers systematic and detailed explanation, examples from other sciences like chemistry and physics; marital status: married, two children; driver of a family van; favourites: reading works of D. Hofstadter, hiking, holidays in Switzerland; Susan, graphics design teacher, 29 years old, creative and modern approach to teaching, prefers self-driven and self-responsible student work; marital status: single; no car driver but bike and train rider; favourites: hiphop music, visiting arts galleries, painting, dancing, holidays in London, UK. (Note: The cigarette in Hans' picture is unchanged students' work. It remains to decide whether a smoking teacher persona is politically correct. This leads us to the problem, when defining teacher personas, whether to follow the ideals of taste and coolness that the average student has or that the majority of our society has.)

Fig. 1: Examples of teacher personas developed in K. Baumann's seminar at FH Joanneum's department of Information Design:

3. CONCLUSIONS

In this paper we intended to outline that in many cases technology makes a much more personalised and adaptable approach possible than the one of human teachers during face-to-face classes. In particular, CBT and WBT systems can personalize perfectly the information items for any learner individually by exploiting user preferences (like preferred media types, preferred learning strategies, previous knowledge and gained knowledge level of the user, etc.). In addition, collective filtering of the behaviour of learners allows to gain knowledge about groups of learners which can help individual users of such groups to get the proper learning material. As an innovative and novel system, the eye-tracking supported adaptive e-learning framework can compose a more fine-granular user profiling and even record emotional reactions (excitation, exhaustion and concentration) by the learners. A lot of different approaches of virtual tutor systems assists learners at their learning sessions and partly allows complementary ways to gain new insights about the use of knowledge. Only to mention an interesting system, the Virtual Student Clone transforms the learner in the sphere of the teachers, and forces the process of knowledge assimilation.

Today's human-computer interaction still lacks the emotional component thus providing the learner with the feeling of being treated in an impersonal way. Starting with the book of Rosalind Picard in 1997 a new emerging research field has been introduced. For those interested in the topic, various theories and cases are presented in [Paiva 2000] that show how to bring an affective dimension into the interaction between users and computer applications. However, further interdisciplinary research is needed to better understand the role of affect in human-computer interaction. Possible application domains of user centred applications adaptable to emotions are manifold, for example in many dimensions adaptable e-learning systems, personalised counselling services, technical support, marketing applications, adaptable help systems and many others.

In the future, apart from novel and innovative approaches, adaptable applications should also consider compliance with principles like visual clarity, consistency, compatibility, feedback, explicitness, appropriateness, flexibility, control, error correction and prevention, user guidance and support. Virtual learning systems will increasingly penetrate learning frameworks for virtually any applications. However, on a long-term perspective, such virtual systems will meet the learners' and society's needs only in concert with face-to-face learning and group learning.

References

[ALICEBOT] A.L.I.C.E. AI Foundation. Alicebot and AIML Documentation; last visited 2003-05-13 http://www.alicebot.org/documentation/.

[Beaumont 1995] Beaumont I., Brusilovsky P.: Adaptive Educational Hypermedia: From Ideas to Real Systems. Proceedings of ED-MEDIA 95, Graz, Austria; June 17 – 21, 1995,.93 – 98.

[Boyle 1998] Boyle C.F., Encarnacion A.O.: MetaDoc: and Adaptive Reading System. Adaptive Hypertext and Hypermedia, Kluwers Academic Publ., NL, 1998

[Bruns 2003] Bruns B.: Liza – die Virtuelle Tutorin. A talk on the LearnTec 2003

[Brusilovsky 1998] Brusilovsky P.: Methods and Techniques of Adaptive Hypermedia. Adaptive Hypertext and Hypermedia (Ed.: Brusilovsky, Kobsa, Vassileva). Kluwers Academic Publ., NL, 1998

[Buckley 1999] Buckley, D.; Coleman, W.; Cohen, M.; Stewart, R.: Interactive Multimedia Learning Environments: Tools to Foster Transition to the Learning Paradigm; In Proceedings of WebNet'99, 1999, AACE, Charlottesville, 155-159.

[Cooper 1999] Cooper, A., Saffo, P.: "The Inmates Are Running the Asylum: Why High Tech Products Drive Us Crazy and How To Restore The Sanity", Sams, 1999.

[Dietinger 1999] Dietinger, Th., Gütl, Ch., Pivec, M., Maurer, H. : "Targeted Information Retrieval", Proc. ICCE'99, IOS Press, Amsterdam, vol. II, 355-358.

[Gütl 1999] Gütl Christian, Hermann Maurer, Maja Pivec: Learning on Demand using xFIND: An Improved Way for Ongoing and Lifelong Learning as a Smart Module for the GENTLE Learning Environment, Proc. Of ICCE' 99.

[Gütl 2002] Gütl Ch., Pivec M.: Virtual Tutor. Proc. Of ED-MEDIA'02, 668 – 672.

[Gütl 2003] Gütl Ch., Pivec M.: A Multimedia Knowledge Module Virtual Tutor fosters Interactive Learning (to be published in the Journal of Interactive Learning Research)

[Hockemeyer 1997] Hockemeyer C.: RATH, A Relational Adaptive Tutoring Hypertext WWW – Environment, Institut fuer Psychologie, Karl-Franzens-Universitaet Graz, 1997/3.

[Hothi 1998] Hothi J., Hall W.: An Evaluation of Adapted Hypermedia Techniques Using Static User Modelling. Proceedings of the 2nd Worshop on Adaptive Hypertext and Hypermedia of the Hypertext'98. Pittsburgh, USA, 1998

[ETLEARN 2003] Eye-Tracking Supported Adaptive E-Learning, Project Homepage, last visit 2003-07-15, http://www2.iicm.edu/etlearning

[Fryer 1999] Fryer B.: Campaign for Learning - Definition of Learning, London, UK, http://www.campain-for-learning.org.uk/learndef.htm London, 1999, Vol. 2, p. 718-724.

[Jordan 1998] Jordan, P.W.: An Introduction to Usability. Taylor & Francis, 1998.

[Lennon 1994] Lennon J., Maurer H.: Lecturing Technology: A Future With Hypermedia. Educational Technology 34, 4 (1994), p. 5-14.

[Maurer 1999] Maurer H.: A critical look at Web Based Training efforts. Proc. of HCI99, Lawrence Erlbaum Assoc. Maurer H.: WWW needs more Interaction. Proc. of Informatik'99, Springer Verlag, 1999, p. 4-10.

[Paiva 2000] Paiva A. (Ed.): Affective Interactions: Towards a New Generation of Computer Interfaces. Springer Vrlg., 2000, ISBN 3-540-41520-3

[Picard 1997] Picard R.W.: Affective Computing. MIT Press, 1997, ISBN 0-262-66115-2

[Picard 2000] Picard R.W.: An Interview with Rosalind Picard. Paiva A. (Ed.): Affective Interactions: Towards a New Generation of Computer Interfaces. Springer Vrlg., 2000, pp. 219 - 227.

[Pivec 2003] Pivec, M., Baumann, K.: "Adaptation and Personalisation Issues from the Perspective of face-to-face Teaching vs. e-Learning", paper presented at i-Know 2003 conference in July 2003 in Graz, Austria, in: Tochtermann, K., Maurer, H.: J.UCS, Journal of Universal Computer Science, Proceedings of i-Know '03, Springer.

[Schroeder 2002] Schroeder R. (ed.): The Social Life of Avatars. Springer Vrlg., 2002, ISBN 1-85233-461-4

[Seeberg 2003] Seeberg C.: Life Long Learning. Springer Vrlg. 2003

[Spitzer 2002] Spitzer M.: Lernen. Gehirnforschung und die Schule des Lebens. Spektrum Akademischer Verlag, 2002 ISBN: 3827413966

[Steiner 2000] Steiner V.: Exploratives Lernen. Pendo 2000

[Weizenbaum 1966] Weizenbaum, J.: “ELIZA - A computer program for the study of natural language communication between man and machine.” Communications of the ACM 9(1): 36-45. 1966.