Gender-Biased Adaptations in Educational Adaptive Hypermedia*

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1 Introduction

Studies (for instance, [1, 2]) show that there is a statistically relevant gender difference in computer usage. In this paper we address the question of what are the causes of this problem and how it can be relieved by adaptive means.

In trying to design systems that are sensitive to individual differences there is a dilemma – how can you make the system behave in a way appropriate for each individual without forcing people into stereotypes? We propose that the group characteristics can be taken as weak defaults and coupled with an adaptive mechanism to quickly take account of individual differences.

This paper starts with a summary of a study which derives a model of the mental factors that influence computer usage. Then, we refine that model and make it the basis of a Bayesian Net student model. The main section describes suggestions for Adaptive Hypermedia targeting the relevant mental factors and how adaptivity can help to avoid clichés and thus discrimination.

2 Gender Differences in Computer Usage

In [2], Dickhäuser and Stiensmeier-Pelster describe a study in which they investigate the causes of gender differences in computer usage. They derive a model which describes the internal factors and variables that influence the choice of an individual whether to use a computer.

In the model, the *attribution index* (the causes people attribute their (un)successful experiences to, e.g. personal incapability vs. computer failure) influences the *self-concept of ability* (judgment of the ability to work with a computer). The self-concept of ability determines the frequency of their *computer use*, the *value* (individual perception of value of working with a computer in a specific situation) and the *expectation* of using a computer successfully (additionally influenced by value). Value and expectation determine a person's *choice of using a computer* in a specific situation.

The values of some of the variables differ significantly between average male and female students. Generally speaking, female students have a significantly lower self-esteem with respect to their abilities in handling computers than males

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do (see also [3, 4]); they expect less success from an interaction with a computer, and are more likely to blame themselves in case something goes wrong. As a result, women considerably less often use a computer as a tool than men do.

3 Extended Student Model

The model provides the basis for a not yet implemented Bayesian Net student model (Figure 1) whose nodes represent probability variables and whose arrows represent conditional dependencies of variables. The extended model contains additional variables (in italic font) because it represents mental factors relevant for educational adaptive hypermedia. Note that some new variables are behavioral rather than mental characteristics, e.g., *accept help*. The value of those non-mental probabilities can be diagnosed from behavioral symptoms when working with a learning system as opposed to mental characteristics that are diagnosed from questionnaires.

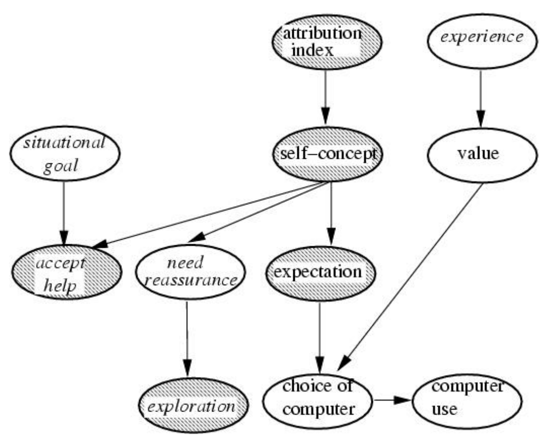

Fig. 1. Bayesian Net Student Model

4 Consequences for Educational Adaptive Hypermedia

Using the extended model, several adaptations can take place which target those variables (marked by a dark background) that can be directly influenced.

Influencing the Failure Attribution Bias. In case of a system error it should clearly be specified that it is not the user who is to blame. This has to be announced as soon as possible, before a system failure can possibly occur.

In e-learning, a user may have unsuccessful experiences due to her/his lack of own capability or own misconception. In particular, the problem solving process needs to be supported by offering guidance on how to solve the problem successfully and to prevent a mis-interpretation of an individual mistake as the system's fault. This is especially important, if interactive tools are used for exercises. In this case, the feedback should prevent a student to think that he/she is not able to solve a problem because of bugs in the tool. Therefore, in addition to stating that a solution step is not applicable in the current situation, feedback can provide a link to a list of applicable commands.

Preventing an Inadequate Judgment of Computer-Specific Capabilites. One of the consequences of a low judgment of computer-specific capabilites is a reluctance vis-à-vis exploring and using all features of a system. This is why a system should support and encourage a user's curiosity. Special emphasis should be put on first-time users of a system. A user should not be be overloaded by the features of a system but still know about the possible interactions that the systems offers on top of those from non adaptive hypermedia, i.e. by adaptively adding features to menus. Additionally, after some sessions the system should provide a list of the features not yet used, accompanied by an explanation why they are useful and an invitation to use them. When a feature is used, the system may immediately provide positive feedback together with an explanatory link to similar features that were not yet used. The links can be annotated using techniques of adaptive navigation support.

Raising the Expectation of Success Adaptively. A low expectation of success is a severe hindrance for using a tool or a software and in addition, negative experiences will be perceived more highly. One way to raise the expectation of a successful interaction consists in making these interactions explicit. For instance, exploring a hitherto unused feature can count as an successful experience on which the system provides feedback at the end of a session, e.g., by presenting a list of features used for the first time. With respect to the user's performance in a session, on logout time the system should provide a list of accomplishments achieved during the session, e.g., a list of solved exercises, read topics, etc.

How to Scaffold Help-Seeking Adaptively. Users need to be supported in using help correctly. Some users request too much help, other users are not much inclined to use help at all although it would improve learning. Therefore, a system needs to specially support users to notice the help opportunity and to use it the way they benefit most of it. Gräsel's experiments show that offering help is not enough but a special visual focus has to be put on the help as well [5]. In case a learner ignores highlighting of help and help-seeking has a low value, a help menu can open automatically. This will be interpreted as obtrusive by most users, therefore the help messages has to make explicit the reason why the menu was offered, i.e., by listing the actions of the user used for diagnosing the need for help.

Influencing the Situational Goal of a Session. Certain instructional items (such as worked-out examples with a request to self-explain) can focus the learner on understanding and reasoning, and stimulate such goals different from pure performance goals. Such items can be introduced adaptively into hypermedia generated by such systems as ActiveMath [6].

5 The Escape Route from Cliché

A simplistic implementation of the described features would ask the user for his sex and adapt the system correspondingly. The problem with this one-time-adaptation approach is that users are faced with a system that incorporates a cliché and therefore, possibly scares off all users not exactly matching a stereotype. Using the sex of a user as a basis for adaptation has one definite advantage: it is easy to collect the information. However imprecise a differentiation on this basis may be, statistics show that this single information can provide information about an individual user that holds with a certain degree of probability. Over time and ideally, an e-learning system identifies the user's aptitudes, cognitive style, capabilities, and other individual characteristics and adapts accordingly.

Therefore, the sex of a user can initialize certain values in the user model, for instance, in the model of Figure 1, the initial empirically average values. But then, user modeling continues rather than stopping at the level of averages and stereotypes. Individual differences of some characteristics can be assessed by monitoring the actions of a user. This information can be used to further refine the user model and to make the transition from the stereotype to the individual.

On way of assessing the individual attitudes consists in interactive choice of features on an individual basis. Each adaption should be accompanied by a possibility to confirm or disallows further application. This enables the user to influence the adaptations in the first place. Additionally, all settings should be accessible in a configuration panel. The decision of the user which feature to employ updates the user model as well.

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