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Allen, B. (2000) Individual differences and the conundrums of user-centered design: Two experiments. *Journal of the American Society for Information Science*. April 2000. 51(6); p. 508.

Summary of the Experimental Study

The focus of the experimental study are individual differences among users of the virtual environment and the ways to overcome those differences using various software design features. The specific experiments examined the perceptual speed and spatial scanning, and testing the hypotheses that there would be a significant interplay between cognitive abilities of the user and design features of the software. Two experiments were performed - one testing users' interaction with the interface, and other testing the attitude of users toward customizing the interface.

For the purposes of the study, the interface was developed that, in addition to alphabetized term list and one filed information display, had a computer-generated word matrix and multiple-field record display. Both features were designed as aids for visual mapping of the information contained in the database. In the first experiment that tested correlation between spatial visualization capabilities and different combinations of tasks and interface features, the results were statistically analyzed using Analysis Of Variance (ANOVA). The conclusion was that two-dimensional mediators like the word map helped people with lower-level spatial abilities, but did not significantly improve searches for people with high-level spatial abilities.

A second experiment tested how users, when given an option to customize the interface, select system configurations. In the experiment, volunteers were given an option to change the interface and use any combination of the interface features, while performing their searches. The results showed that most of the people did not change the initial

interface, and even those who did, did not change it in the way to take best advantage of the system in relationship to their cognitive abilities.

The research concludes that, overall, the compensation approach is probably the best approach to interface design in customized information systems. However, it remains unclear how to achieve the match between user characteristics, tasks they need to perform and interface they need to use. Self-configuring systems require users to understand their potential weaknesses in the particular virtual environment understand system configuration and understand how they can modify them. All available research points toward the need for some kind of mechanisms that would assist users to optimally configure the system; however it is unclear what would be the best way to achieve that.

Experimental Study Critique

Allen's article is published in the thematic issue of *Journal of the American Society for Information Science* that focused on individual differences in human-computer interaction and ways to overcome those differences. The introductory article, written by Chaomei Chen, Mary Czerwinski and Robert Macredie (Chen et al.), explains the historical development and theoretical foundations of approaches for solving the individual differences in virtual environment, and without that article it would be very difficult to understand Allen's premises for the development of the hypothesis and design of experiments. In his article he only briefly touches the definition and significance of two basic approaches of dealing with the cognitive abilities among users and assumes that his reader is well acquainted with terminology and the past research in the field. However, even after careful reading of other articles in the same issue, it is difficult to see what the scientific significance of Allen's experiments is and how they contributed to further understanding of outlined problems.

According Chen et al. there are three ways to design interface to meet individual differences: (1) the challenge match, where a user is forced to change behavior and become more flexible; (2) the capitalization mach, where system is developed with

strengths of the user in the mind; and (3) the compensation match where design offsets users' deficiencies through some kind of compensation, either training or a mediating feature [Chen et al. 2000, p. 500]. In his experiments, Allen concentrates on compensatory and capitalization approaches and analyzes their effectiveness.

The specific cognitive abilities (i.e., differences between individual users) investigated in this research, were perceptual speed and spatial scanning. The author's working hypothesis is that there will be significant interaction between cognitive abilities of the user and design features: "either the compensation or the capitalization effect would be found when users with different levels of abilities used different information systems." [p. 509]. However, the author himself acknowledges that the complexity of the possible interactions between cognitive abilities, specific tasks and software design make it impossible to form specific hypotheses about the possible nature of the interactions.

The first experiment tests interaction between user and the two-dimensional representation of information - word map and multi-window bibliographic record display - which were developed to aid users in creating spatial maps of the information. The word map was created based on a computer generated matrix. The multi-field record displayed information in specific fields that were consistent for all records. The users – 80 student volunteers – were pretested to determine their spatial abilities. After categorizing their spatial abilities, volunteers were divided in four groups, and each of them performing one of two tasks – searching for "few good articles" to include in term paper or "as many as you can find on topic" for the journal article. Different tasks were developed to test the theory that the task that is being accomplished by the user play has a significant effect in cognitive style applied in searching strategies. Each of four groups was tested with the interface with a different combination of the design features.

It remained unclear what were the theoretical foundations for creating two particular interface features and how this particular visualization is particularly helpful to spatially-challenged users. The explanation of experiment design does not make clear how much of the experiment tests the interface design itself, and how much the individual

differences between users. In the analysis of the results Allen admits that results "of the two search tactics as intervening between system and users, on the one hand, and outcomes on the other illustrates that both capitalization and compensation can work indirectly, by influencing the choice of search tactics."

Another article published in the same issue, describing similar experimental study using three-dimensional representation of indexed terms, noted the observation of the users that they had trouble using the mapping because they did not understand underlying logic of grouping mechanism [Chen, 2000, p. 538]. The main conclusion of that article was that the most significant factor affecting the effectiveness of information gathering is experience in on-line searching. Allen never addresses these issues in his study, nor is it clear if he takes them in account when analyzing his results.

The ANOVA statistical analysis of results of Allen's experiment confirm that individuals with higher levels of perceptual speed achieved higher recall regardless of the interface feature, but did not profit in any way from use of the word map. Allen never addresses that question, although even Chen et al. observes that particular finding in the introductory note. They suggest that, perhaps, the word map, although beneficial for users with low spatial abilities, "did not present feature on which high spatial individuals could capitalize" [Chen et al., p. 502]. However, in the summary of the findings of his experimental study of a spatial-semantic virtual environment, Chen notes:

> "An important finding was that users developed different mental maps of an area based on the nature of interrelationships concerned. Two subjects in our study mentioned that they would have organized the virtual world differently...." [Chen 2000, p. 541]

People with highly developed spatial abilities develop their own mental maps and do not find visual maps developed by others particularly helpful.

The second experimental study explored how (and if) users will customize the interface, if given the option. The experiment was designed to test two opposing approaches of matching users with the interface that would use be best for their cognitive abilities. One

approach advocates modifying the system to the user through some kind of diagnosis. The second approach advocates creation of a generic interface with features that could be modified by a user.

The study used new group of volunteers, but the interface and procedures were the same as in the previous experiment. However, this time volunteers were able to switch between the features on the interface. There were no "default" settings - different volunteers were introduced to the different initial setting and they had option to stay with that or change. It is unclear if users were specifically notified of other features or just encouraged to explore while asked to perform search for particular information. It was noticed that many users checked out the word map as novelty, but than went back and performed the searches with initial interface settings. Exactly half of the group chooses not to make any changes in interface whatsoever. Changes users made in the interface had no significant relation to their cognitive abilities and possible optimalization of the system that would correlate to their abilities. The conclusion was that, if given an option, the user does not take advantage of compensation effects.

This attitude toward changes, i.e., "do not fix it if it is not broken" attitude, is a well-known phenomena of economic development and social learning, and therefore Allan's findings are not particularly surprising. The field obviously understands the phenomena and Chen et al. specifically introduce the "challenge match," i.e., forcing user to change the behavior, as one of the interface design approaches. Allen never addresses this issue and it is unclear how would experiment, designed as it is, possibly yield any other result.

Allen's analysis of the results is that "more directive manner of matching users with system configurations seems to be called for." [p. 519]. He proposes design of the interfaces that "sensible inferences could be drawn about [users] cognitive abilities from user behaviors, and that systems could configure themselves in response to these inferences." In other words, to take away the decision of system configuration from users by creating the system that will do that for them (for their own good and best advantage).

Other findings of the study are equally ambiguous and contradictory and even use of sophisticated statistic could not make up for the vague hypothesis and weak intellectual foundations of the experiments. In his article Chen at least have intellectual honesty to admit that “we were not able to reject the null hypothesis...” [Chen 2000, p. 540] and proceed with qualitative analysis of users’ feedback, and in the process reach some very insightful conclusions – mainly that practice make perfect and that, if given chance, humans have uncanny ability to adapt their cognitive strategies to the changing environment.

References

Chen. C., Czerwinski M. and Macredie. R. (2000) Individual differences in virtual environments - Introduction and overview. *Journal of the American Society for Information Science*. Apr 2000. 51(6); p. 499.

Chen C. (2000) Individual differences in a spatial-semantic virtual environment. *Journal of the American Society for Information Science*. Apr 2000. 51(6); p. 529.