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The Effect of Personality-Aware Computer-Human Interfaces on Learning[1]

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Abstract: Traditional software used for student-centered learning typically provides for a uniform user interface through which the student can interact with the software, and through which the information is delivered in a uniformly identical fashion to all users without regard to their learning style. This research classifies personality types of computer science undergraduate students using the Myers-Briggs Type Indicator; relates these types of personalities to defined learning preferences; and tests if a given user interface designed for a given learning preference enhances learning. The general approach of this study is as follows: given a set of user interfaces designed to fit personality types, provide a given user interface to participants with the matching personality type. In the control group, provide participants with a randomly chosen user interface. Observe the performance of all participants in a post-test. Additionally, observe if the test group had an enhanced learning experience. Quantitative results indicate that personality-aware user interfaces have a significant effect on learning. Qualitative results show that in most cases, users preferred user interfaces designed for their own personality type. Preliminary results show that for introverted intuitive persons and extraverted intuitive persons, the effect of a personality-aware human-computer interface on learning is significant.

Key Words: Human-Computer Interaction, e-learning, Myers-Briggs Type Indicator, MBTI
Categories: H.5.2, K.3.2

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1 Introduction

1.1 Purpose

This study was designed for an e-learning environment. It examines the potential effect of user interfaces tailored to the user's personality on the user's ability to learn. Few studies have attempted to examine the design of personality-aware user interfaces and their effects on users in an e-learning context.

1.2 Background

Traditional dialogs that take place between a human tutor and a student typically involve an exchange of viewpoints, where the tutor is able to explain things from a variety of angles in order to ensure the student's understanding of the subject. We could say that there is *interaction* and that the tutor is *adaptive* to the dialog at hand. In this context, the interaction is between the tutor and the student, and the adaptivity is the tutor's ability to explain the material in a variety of ways.

This is not the case when software is used as a teaching tool. When software is used for student-centered learning, terms such as *interactive* and *adaptive* are often used in a different context, to describe attributes of the *interface* between the computer and the user, under the umbrella of a field known as Computer-Human Interaction (CHI). These terms may then infer that the user has a high degree of control of the teaching package, or that the package adapts to the user's wishes, in the way that a human tutor might. These terms are widely misused, and notions of interactivity and adaptivity vary considerably.

Software used in learning has been, historically, locked into a mode of constraining the user into little or no choice. On the other hand, modern hypertext-based multimedia systems offer considerably greater choices. In this paradigm, there is almost total freedom of choice, in the sense that the user is left to decide on navigational direction – there is no built-in teaching model. Putting 'personality' into user interfaces may prove useful in the design of software used for learning, in the hope to fit virtual teaching to the learning preferences of students. This is further suggested by [Turkle and Papert 1992] in their discussion of "epistemological pluralism", encouraging the incorporation of personality considerations in the learning medium.

Within each student's personality is an individual study behavior, which stems from certain cognitive preferences. Specific learning preferences are sometimes called *learning styles*, and they serve as stable indicators of how learners perceive and interact with learning environments. Learning style can be seen as the *preferred* manner in which information is processed. Teachers also have styles - these are characteristic ways of teaching which emanate from their own personalities and preferences. Where there is a mismatch between styles of teaching and learning, the student may experience psychological discomfort, and knowledge transfer may be impeded.

1.3 Theory Base

In this study, several factors must be taken into account: a) how humans are cognitively different; b) how humans process information; and c) how information can be presented with the use of software. Carl Jung's [Jung 1923] personality type theory helps discern differences in human cognizance and thus supports (a), the Theory of Cognitive Structures supports (b), while various studies in the field of Human-Computer Interaction (CHI) support (c).

1.3.1 Carl Jung's Personality Type Theory

According to [Jung 1923], the four functions of the mind are *Thinking, Feeling, Sensation,* and *Intuition.* They are the main avenues of knowing and relating to reality. By making a statement like "I'm thinking that…", or "I feel happy", or "I have a hunch…", a person is telling more about the way he is experiencing reality at the time than about the actual nature of that reality. By making statements like these, one is merely reporting the dominant mental activity that is taking place in consciousness at the time. Jung defines a psychological function as "a certain psychic activity that remains theoretically the same under varying circumstances and is completely independent of its momentary contents."

The four functions interrelate and stimulate each other, but one of the functions dominates consciousness most of the time. That *dominant function* orients a person in any given situation. Jung theorizes that depending on his psychological type, a person is predisposed to favoring one of the four functions.

Jung's type theory specifies three dimensions: Extraversion/Introversion (E/I); Sensing/Intuition (S/N); and Thinking/Feeling (T/F), and also alludes to a possible fourth dimension: Judging/Perceiving (J/P). [Myers-Briggs 1993] formally added the latter dimension to the Myers-Briggs Type Indicator (MBTI), an instrument used to measure type (also see [Myers and McCauley 1985]).

1.3.2 Human Information Processing and the Theory of Cognitive Structures

A dominant meta-theory in cognitive psychology is human information processing. According to this theory, the human brain is a system that is active and organized. [Atkinson and Shiffrin 1968], [Atkinson and Shiffrin 1971] and others [Broadbent 1958], [Waugh and Norman 1965] developed models of human memory consisting of three major components: sensory memory, short-term memory and long-term memory. According to Tulving, [Tulving 1972] there are two classes of information stored in long-term memory: episodic and semantic knowledge. Episodic memory refers to a person's autobiographical memory, to the personally experienced and remembered events of a lifetime. Semantic memory, on the other hand, contains general world knowledge, including knowledge of the vocabulary and rules of language, and the general knowledge that relates to concepts and ideas to one another. The current conception of learning based on the semantic knowledge principle is that learning consists of building or modifying cognitive structures by constructing new nodes and interrelating them with existing nodes and with each other [Norman and Bobrow 1976], [Norman et al. 1976]. [Shavelson 1974] demonstrated that during the process of leaning, the learner's knowledge structure begins to resemble the instructor's. Others [Garskoff and Houston 1963], [Geeslin and Shavelson 1975] have

shown that, with instruction, knowledge structures of students changed considerably and corresponded more closely to that of the content structure. Learning could thus be viewed as the mapping of subject matter structure onto the learner's knowledge structure.

1.3.3 Computer-Human Interaction (CHI)

Most users interact with computers by typing, pointing, and clicking. The majority of work in human-computer interfaces in recent decades has been aimed at creating graphical user interfaces (GUIs) that give users direct control and predictability [Turk and Robinson 2000]. These properties provide the user a clear model of what commands and actions are possible and what their effects will be; they allow users to have a sense of accomplishment and responsibility about their interactions with computer applications.

It is important to understand human information-processing characteristics, how human action is structured, the nature of human communication, and human physical and physiological requirements. Phenomena and theories of memory, perception, motor skills, attention and vigilance, problem solving, learning and skill acquisition, and motivation are central to the development of good user interfaces. In addition, an understanding of users' conceptual models, as well as models of human action are essential [SIGCHI 1992].

1.3.4 Personality, Learning, and CHI

There have been too few studies to draw a definitive conclusion on the relationship between personality type, user interfaces, and learning. There has been evidence that there may be a significant correlation [Matta and Kern 1991]. [Crosby and Stelovsky 1995] determined that the Sensing/Intuitive dimension was significantly related to instruction in a multimedia environment. [Bishop-Clark and Wheeler 1994] also found a significant relation between MBTI types and performance in an introductory computer-programming course. [Gurka and Citrin 1996] evaluated the problems of conducting a study on the effectiveness of algorithm animation, and noted that the use of a combination of both qualitative and quantitative approaches is likely to be the most effective. This recommendation was followed in this study, and both qualitative and quantitative data were collected. The primary questions regarding the influence of learning style and user-interface on the degree of learning is answered by quantitative data, such as posttest scores and time spent using the interface. Qualitative data, in the form of interviews, written evaluations and transcriptions of participants thinking out aloud helps support the conclusions. They also aid in answering secondary research questions that assess how well the user interfaces were accepted and whether those interfaces were felt to be effective as a learning tool.

There are sixteen possible combinations of type as a result of the application of the MBTI. The fourth dimension (Judging/Perceiving) is correlated with the Thinking/Feeling dimension [Carlyn 1977]. Since this fourth dimension does not contribute independently to the understanding of personality, we do not include it in the study. This leaves Jung's original three dimension, which are completely orthogonal in their description of personality type, and can therefore be treated as independent variables. After further consideration, the Thinking/Feeling dimension

was also dropped, as the concept being presented by the user interfaces (in this case the concept of a binary tree) does not lend itself well to this dimension (see [Section 4] for more on this). The elimination of two dimensions reduces the number of possible combinations of type to four (see [Tab. 1]).

Extraverted iNtuitive (EN)	Introverted iNtuitive (IN)
Extraverted Sensing (ES)	Introverted Sensing (IS)

Table 1: MBTI types considered in the study

An important question arises: can computers be made to have 'personalities' resembling human personalities? It has been shown [see Nass and Moon et al. 1995] that even the most superficial manipulations can be made to produce personality, with powerful effects.

2 Methods

2.1 Research Plan and Experimental Design

Participants were drawn from a pool of undergraduate computer science students typically in their freshman year. They were screened to make sure that they have no knowledge about the computer science concept being used in the experiment. Participants were placed into three groups based on their grade point average, in order to reduce the possibility of outliers. Each one of these groups was further divided into an experimental or control group.

The study was conducted anonymously, with no possibility for tracing results back to individuals. Results are currently available for introverted intuitive (IN type) and extraverted intuitive (EN type) individuals.

Students were given 30 minutes to use their assigned user interface and learn a computer science concept. In this case the concept of binary tree was used. Students were then given a posttest to assess their understanding of the subject. Some questions in the posttest required students to draw their own conclusions, rather than simply remember what was shown or discussed in the user interface. The post-test contained 10 questions each worth 10 points. For those questions that could be answered subjectively, partial credits in increments of 5 points were given for partially correct answers. MBTI scores take on integer values indicating the "degree" to which one is introverted, extraverted, etc. An attempt was made to select individuals who were "well into" the range of the desired dimension in order to reduce outliers.

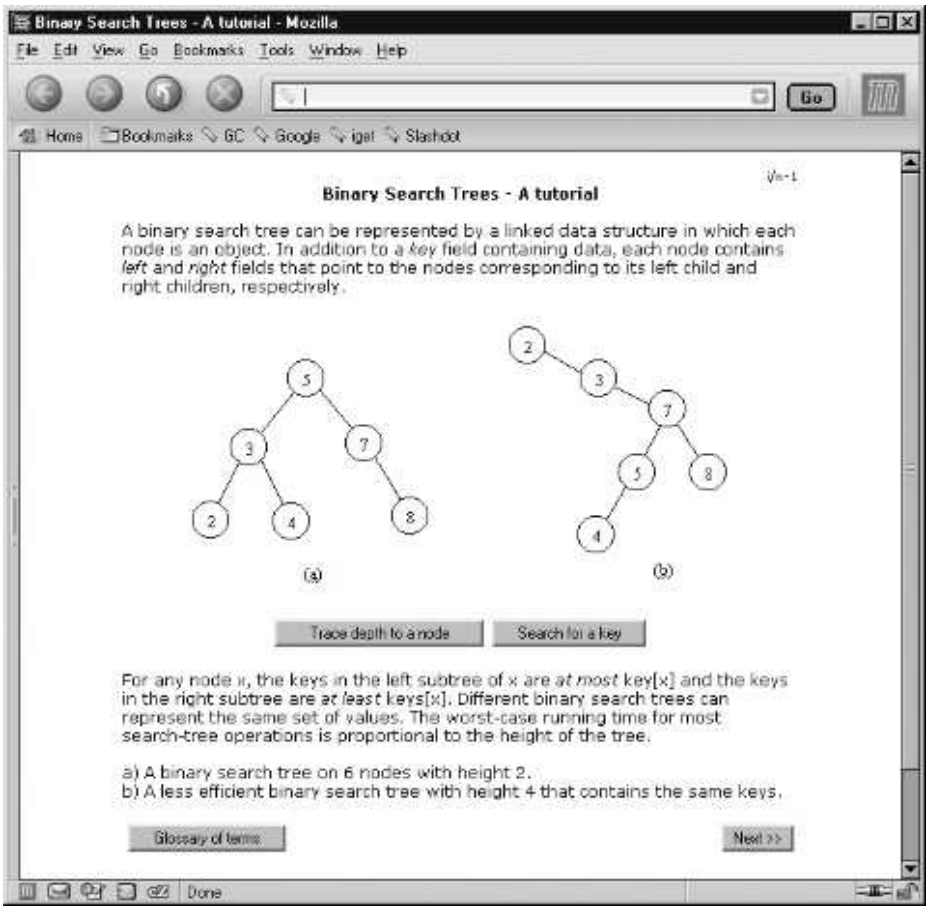

Figure 1: Portion of a user interface designed for the introverted intuitive type

Since the Jungian dimensions are completely orthogonal, it would be possible to design interfaces that brought out elements of a particular dimension much more strongly than the other dimensions and hence the measurement of the effect of such elements would be possible. Properties of each dimension, pertaining to education and learning, were collated from the literature ([Myers-Briggs and Myers 1980], [DiTiberio 1996], [DiTiberio 1998], and [DiTiberio and Hammer 1993]) and interfaces were designed to bring out those properties. For each interface designed, properties that brought out the strong features of the two given types were used in the interface. For example, in designing the user interface for the IN dimension, elements that stand out for both I and N dimensions were used in the design. [Fig. 1] shows one screen of an interface designed for the Introverted iNtuitive (IN) type. [Fig. 2] shows one screen of an interface designed for the Extraverted iNtuitive (EN) type. Material about binary trees was adapted from textbooks (See [Aho et al. 1983] and [Cormen et al. 1986]).

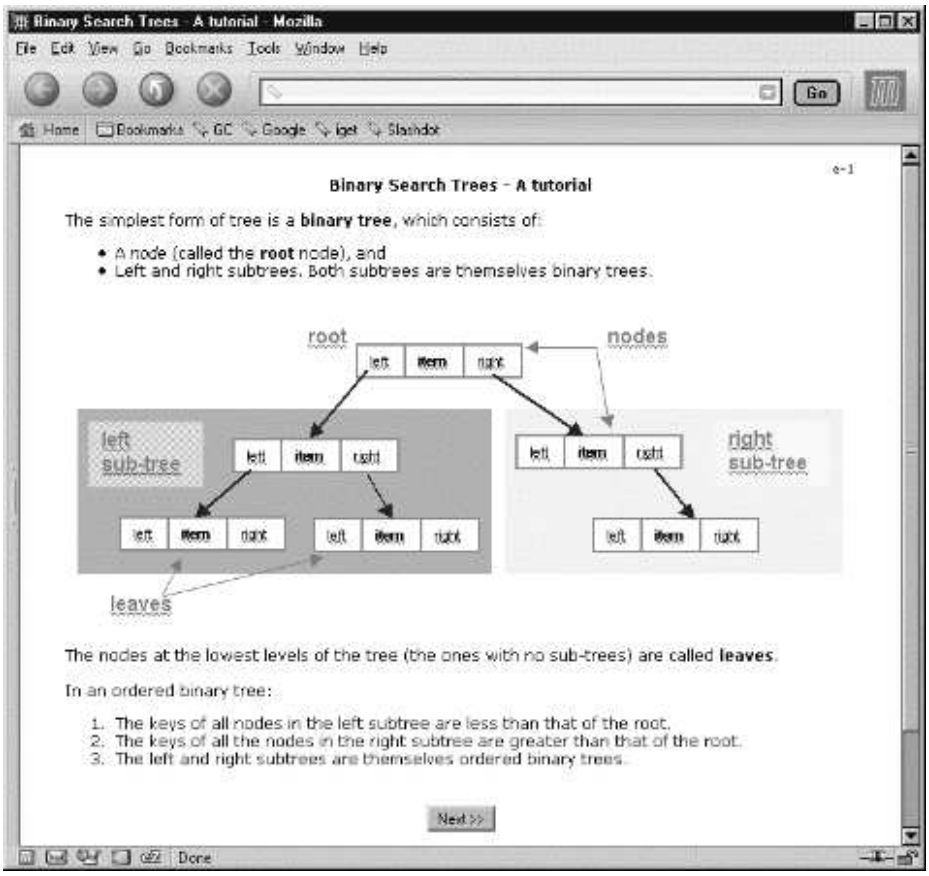

Figure 2: Portion of a user interface designed for the extraverted intuitive type

3 Results

Quantitative results are currently available for the introverted intuitive (IN) type and the extraverted intuitive (EN) type. Data were collected from 90 participants per type, who were significantly introverted intuitives or extraverted intuitives on the Myers-Briggs scale. Each of the three groups (low, average, and high GPA) contributed equally. Thus, each experimental and control group consisted of 15 participants. The results are as shown in [Tab. 2] and [Tab. 3].

	Low Gpa Group		**Medium GPA Group**		**High GPA group**	
	Ctl	Exp	Ctl	Exp	Ctl	Exp
1	50	55	50	65	75	80
2	65	45	70	75	85	90
3	60	55	70	75	95	90
4	55	60	75	75	90	85
5	55	55	55	75	75	85
6	45	70	80	90	80	90
7	55	55	70	70	80	85
8	45	60	70	75	85	80
9	45	55	75	70	90	95
10	55	55	65	80	75	95
11	35	60	65	70	80	90
12	45	50	75	85	85	85
13	35	55	75	80	75	85
14	55	55	65	80	80	90
15	60	65	65	55	75	75
Ave.	50.7	56.7	68.3	74.7	81.7	86.7
Std. Dev.	8.8	5.9	7.9	8.3	6.4	5.6
P	0.038		0.042		0.031	

Table 2: Posttest score analysis for Introverted Intuitive (IN) individuals.

4 Discussion

The results show that the effect of personality-aware interfaces on degree of learning is statistically significant ($p<0.05$) for types under consideration, with the average test scores being several points higher for the experimental groups. The interfaces that were used contained elements that strongly bring out properties of the dimensions under study, such that users with personality types of those dimensions find them appealing. In a sense, the interfaces used in the experiment were exaggerated to bring out the effect of type, and purposely diminish the effect of task-centered design, which explains their almost naïve simplicity. However where a type called for more elaborate user interface design, such a design was attempted. For instance, where it was indicated that a certain type favored freedom of navigation, a means to navigate freely was provided, as opposed to a sequential navigation method. It is imperative to emphasize that these results do *not* indicate that user-centered or task-centered designs are not useful. They simply indicate that with more attention to type, a user interface could be made more useful in e-learning, and that a combination of attention to type and proper user-centered interface design is recommended in such an environment.

	Low Gpa Group		**Medium GPA Group**		**High GPA group**	
	Ctl	Exp	Ctl	Exp	Ctl	Exp
1	45	50	65	70	80	85
2	60	50	65	70	85	90
3	55	50	65	70	75	85
4	55	55	60	70	90	90
5	70	55	70	65	75	90
6	50	65	75	85	85	100
7	45	45	70	75	80	90
8	40	65	65	70	85	85
9	50	50	70	70	95	85
10	55	70	65	75	85	70
11	40	55	60	75	80	85
12	35	50	85	75	85	85
13	40	60	75	80	70	90
14	55	70	70	75	80	95
15	55	65	60	65	75	80
Ave.	50.00	57.00	68.00	72.67	81.67	87.00
Std. Dev.	9.26	8.19	6.76	5.30	6.45	6.76
P	0.037		0.045		0.035	

Table 3: Posttest score analysis for Extraverted Intuitive (EN) individuals.

The qualitative aspect of the data is still under study. Participants were interviewed regarding what they liked and did not like about the user interface they worked with. The last question in the interview was open-ended to give participants a chance to give any additional information they deemed important. Preliminary results suggest that users who were given interfaces that matched their own personality type were satisfied with the interface. A fairly common response was a terse "I like it". Those participants offered suggestions on how the interface could be improved, ranging from usability suggestions to content suggestions. Those in the control group voiced more dislike for their user interface.

Regarding dropping the Thinking/Feeling (TF) dimension, as stated in [Section 1.3.4], it was decided that the Feeling dimension was too emotion-driven, and would not lend itself well to the subject being dealt with (computer science concept of binary trees). We believe that this dimension is well worth exploring for other subjects, where emotions have more of a role in the subject matter, for example political science, philosophy, and architecture. This could be the subject of future work.

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