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An empirical study of the effects of interactivity on web user attitude

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Abstract

Despite the growing attention given to Web usability, little is understood as to what Web design features contribute to Web users' attitude, a major component of the usability of a Web site. This research investigates the effects of interactivity level on Web user's attitude towards commercial Web sites. It extends existing Web interface design and usability literature by empirically examining the critical roles of interactivity. Three Web sites with different levels of interactivity were compared in a controlled laboratory experiment. Three eighteen-person groups completed each treatment. The independent variable is the incremental levels of interactivity. The dependent variables are satisfaction, effectiveness, efficiency, value, and attitude towards the Web site. Results suggest that increased level of interactivity on a Web site have positive effects on user's perceived satisfaction, effectiveness, efficiency, value, and overall attitude towards a Web site. Implications for Web site designers and researchers are discussed.
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1. Introduction

Since its conception in 1990, the World Wide Web has been pervasively adopted and has brought about multi-faceted impacts. Today, Web-based information systems could be found in applications spanning commercial, social, educational and entertainment domains. Among them, commercial Web sites undoubtedly have the greatest reach and economic impact. According to McQuivey et al. (1998), business-to-consumer electronic commerce is projected to reach almost $120 billion by the year 2003. In order to derive maximum benefits from commercial Web sites, companies and designers need to ensure that the on-line interface in which the consumers interact with is user-friendly. However, as highlighted by Nielsen (2001), about 90% of current commercial Web sites have low usability. Web sites with low usability will lead to unsatisfied users and the sites will not grow into long-term success (Nielsen, 1999a). Usability is the extent in which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (ISO 9241-11, 1998).

Keeker (1997) calls for a need to research into improving Web usability from a practitioner's point of view. Nielsen (1999b) reports that a growing number of companies are already doing in-house research into improving Web usability. On another front, Benbunan-Fich (2001) also highlights that the academic literature has not given much attention to evaluating the usability of commercial Web sites.

Despite the growing interest towards Web usability, little is understood about the outcomes of Web design features and their contribution towards Web users' attitude, a major component of Web usability. User attitude is important also because it contributes to user's intention to use a system (Ajzen, 1989) while user's intention to use a system is suggested to be the best predictor of actual system use according to the Technology Acceptance Model (Davis et al., 1989). DeSanctis (1983) attests that predicted motivation to use a decision-support system is positively related to later measures of actual system use. Vehovar et al. (2001) also affirm the value of attitude research and indicate that qualitative measurement concentrating on attitude is one of the four major measurements used in the analysis of electronic commerce. User attitude is especially important to commercial Web sites because purchase intentions resulted from on-line visits are found to improve as attitude towards the Web site improves (Stevenson et al., 2000).

Prior research has suggested the potential of Web design features such as interactivity in improving Web usability (Ghose and Dou, 1998). Potential benefits of interactivity include sense of fun and satisfaction (Rafaeli, 1989), engagement and performance quality (Schaffer and Hannafin, 1986; Szuprowicz, 1996), and time saving (Cross and Smith, 1996). Despite its theoretical underpinning and technical availability in the form of Web design tools and technologies, interactivity is not provided on many Web sites as reported by a recent survey conducted on 408 environmental organizations' Web sites. Gilbert Center (2001) reveals that only 35% of the Web sites surveyed provided some form of interaction on the front page.

In addition, the benefits of interactivity on the Web have not been consistently established in empirical studies. While some studies have established the value of

interactivity (e.g. Ghose and Dou, 1998), others have failed to demonstrate the superiority of interactivity (e.g. Bezjian-Avery et al., 1998). These disparate findings suggest that interactivity effects might be contingent upon the Web site purposes, interactivity functions, user characteristics and interactivity levels. In order to better understand interactivity effects, researchers need to examine each of these characteristics systematically as interactivity is merely one of the many factors that will affect the overall usability of a Web site. Variables such as Web site purposes (Ghose and Dou, 1998), interactivity functions (Ghose and Dou, 1998) and user characteristics (Mehlenbacher et al., 2000; Ramey, 2000) have been addressed in extant interactivity literature. Details of these studies will be discussed in Section 2.3.

Despite its significance (Berthon et al., 1996), interactivity levels have not been thoroughly explored in research. As pointed out by Miles and Howes (2000), e-commerce is not merely an information retrieval activity and thus the software systems that support it should be task-domain specific. As such, this study specifically focuses on empirically investigating the effects of interactivity level on user's attitude towards commercial Web sites. It seeks to fill the gap in extant literature by examining the potential Web features that will improve commercial Web sites' usability. Through this study, the researchers hope to surface fresh insights to spur further research in Web usability and provide empirical support for the viability of incorporating interactive features into Web sites.

2. Conceptual foundations

2.1. Usability

Usability has been a central focus of human–computer interaction (HCI) literature and design for many decades. Usability is suggested to be one of three factors determining a system's acceptability (Shackel, 1991). Shackel suggests that a system's acceptability can be defined as a function of three orthogonal dimensions: utility (whether the system does what is needed functionally), usability (whether the users can actually work the system successfully) and likeability (whether the users feel the system is suitable), all balanced against the cost of the system. This framework is an important paradigm in HCI as it provides a high-level conceptualization of the acceptability of any given systems to its intended users. Prior research also indicates that usability is associated with numerous positive outcomes, including reduction in the number of errors, enhanced accuracy, more positive attitude towards the target system, and increased usage (Lecerof and Paterno, 1998; Nielsen, 2000).

The International Organization for Standardization (ISO) defines usability as the extent in which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (ISO 9241-11, 1998). The evaluation of the user interface is an important step towards attaining usability (Lecerof and Paterno, 1998).

With widespread use of the Web, there is an emergence of studies that focus on measuring Web usability. Web usability comprises the Web site's learnability,

throughput, flexibility and user's attitude towards the Web site (Preece et al., 1994). Lindenberg and Neerincx (1999) propose a generic test environment that will facilitate usability testing of Web-based services using the measures of effectiveness, efficiency and satisfaction. Benbunan-Fich (2001) applies the three evaluation parameters proposed by Lindenberg and Neerincx (1999) and uses protocol analysis approach to evaluate the usability of a commercial Web site. Due to the importance of these constructs in usability studies, Frokjaer et al. (2000) recommend that effectiveness, efficiency and satisfaction should be studied as independent aspect of usability and all be included in usability testing.

Nevertheless, Benbunan-Fich (2001) highlights that the academic literature has not given much attention to the evaluation of commercial Web sites' usability despite the fact that about 90% of current commercial Web sites have low usability (Nielsen, 2001). Improving the understanding of user's attitude towards Web site could lead to improvement in the usability of commercial Web sites.

2.2. User attitude and contributing factors

The literature indicates that user's prior positive attitude towards information systems increases the actual use of the system (DeSanctis, 1983). However, user's attitude towards commercial Web sites, a type of Web-based information system, is not positive at the moment and calls for improvements (Nielsen, 2001). Furthermore, little research on investigating the antecedents of attitude formation has suggested what specific Web features can bring about favourable Web user attitude.

Attitude is defined as predispositions to respond in a particular way towards a specified class of objects (Rosenberg, 1960). Many researchers posit that attitude comprises of affective and cognitive components (Perloff, 1993). Affective component refers to the feelings formed without conscious thoughts and they can be expressed in verbal statements of affect. Cognitive component consists of the ideas and beliefs formed through conscious thoughts and they can be expressed in verbal statements of beliefs and values. Some researchers separate a third component, behavioural component, from the affective and cognitive component when the attitude component is about one's action tendencies (Oskamp, 1991). Behavioural component can be expressed in verbal statements concerning behaviour.

The affective component is a crucial element of attitude. It is believed that one cannot have an attitude until she/he has some feelings about the object in question. Attitude can be based entirely on affective feelings (Oskamp, 1991). Rosenberg (1960) demonstrates that changes in the affective component can create continuing parallel changes in the cognitive component. Rosenberg (1960) measures the cognitive component with perceived value and value importance when studying the relationship between affect and cognition. He suggests that strong and stable positive affect towards a given object should be associated with beliefs that it leads to the attainment of a number of important values. On the other hand, strong negative affect should be associated with beliefs that the object tends to block the attainment of important values. Value is defined as conceptions of the desirable means and ends

of action (Oskamp, 1991). It is believed to be a determinant of attitude because once a value is internalized it becomes a criterion for developing and maintaining attitude towards relevant objects and situations (Rokeach, 1972). Many other researchers (Peak, 1955; Tolman, 1951) affirm that the cognitive aspect of a person's attitude may consist largely of expectations about how his values are served through the agency of the attitude object. Both affective and cognitive components are believed to provide guidance to the behavioural component (Rosenberg, 1960). Since attitude towards an object may not be related to any action, many researchers prefer to view attitude as a global evaluation that is determined by or composed of affect and cognition alone (Oskamp, 1991).

Ducoffe (1996) proposes a model for examining attitude with affect and cognition. In the model, affect and cognition together contribute to the attitude towards Web advertising. Affect is measured by emotional effects of Web ads' entertainment. Entertainment refers to the ability to arouse aesthetic enjoyment. The enjoyment resulting from the entertainment may bring about the feeling of satisfaction to the users. Ducoffe (1996) measures cognition as the value of Web ads to users. Besides affect, two other major elements influencing Web ads' value are informativeness (positively correlated with value) and irritation effects (negatively correlated with value) of Web ads. Informativeness refers to the ability to effectively provide information that users search for. This factor contributes to value mainly because it determines the primary effectiveness of Web ads. Irritation refers to any offending effects that may go against what a user values. Irritation can result from a failure to provide ease of use. Ducoffe's (1996) model attests prior attitudinal research that the affective component contributes to attitude formation both directly and indirectly via influencing cognition (Rosenberg, 1960).

Even though Ducoffe's focus is on the attitude towards Web advertising, the key elements studied may have similar effects on user's attitude towards commercial Web sites. The feeling of satisfaction from an on-line experience, much like the affect resulting from entertainment in Web advertising, may contribute both to Web user's attitude and cognition of the Web site's value. Even though the Web is serving multiple purposes, most users come to commercial Web site mainly for information (Nielsen, 1999c). Therefore, as in advertising, the Web's effectiveness in providing information may be the main contributing factor to user's perceived value. Irritation arising from offending effects or time wasted in using the Web site goes against users' value regardless of the type of Web site. Hence, the affect (feeling of satisfaction) and the cognition of the Web site's value may together influence Web user's attitude.

However, little of extant research on attitude antecedents has pointed out what specific Web features can bring about favourable Web user attitude. Furthermore, the potential value of such research will not be practicable until such features are identified. Interactivity could be one such feature.

2.3. Interactivity and interactivity levels

Interactivity is thought by some to be a key technological capability for anyone trying to make sense of the vast amounts of on-line data (Jakobovits, 1997). A

number of researchers have also identified the roles of interactivity in on-line firms' efforts to build a good relationship with their customers (Ghose and Dou, 1998). Newhagen and Rafaeli (1996) opine that interactivity when implemented appropriately is instrumental in differentiating between successful and failing Web sites. Ghose and Dou (1998) also note that the higher the interactivity level of a Web, the more attractive it is. Researchers have indicated that the quest for improving interactivity guides future technological development for the Web (Ha and James, 1998).

Williams et al. (1989) define interactivity as the degree to which participants in a communication process have control over, and can exchange roles in their mutual discourse. Research indicates that user control (Hoffman and Novak, 1996a) and information exchange (Bretz, 1984) are the two key features of interactivity. Increased interactivity may lead to satisfaction (Rafaeli, 1989), increased performance quality (Schaffer and Hannafin, 1986; Szuprowicz, 1996), and time saving (Cross and Smith, 1996).

Several important aspects of interactivity have been found to influence interactivity's effect on Web users. Ghose and Dou (1998) identify Web site purpose and interactive functions as influential factors on interactivity's impact. They observe the general pattern that the impact of "customer support" interactive functions on a site's likelihood of getting into the Lycos Top 5% list becomes slightly stronger when site goals change from those of a "cyber-brochure" to those of a "content/image". They also find that the probability of a site getting into the Lycos list gets larger as the total number of interactive functions found in a given site gets larger. Mehlenbacher et al. (2000) notice the role of user characteristics in influencing on-line interactivity's effect in Web-based learning environment. Their findings reveal that reflective, global learners performed significantly better on-line than active, sequential learners despite the fact that no difference between them exists in the conventional class. Ramey (2000) also highlights the importance of identifying user characteristics in improving a site's effect for Web sites in general.

Research has indicated that interactivity level is a potential variable influencing Web users. Berthon et al. (1996) indicates that the interactivity level of a site would be critical in converting site visitors from interested contacts into interactive customers. Ghose and Dou (1998) note that the higher the interactivity level of a Web site, the more attractive it is. Light and Wakeman (2001) attest Hoffman and Novak's (1996a) theory that relationships between Web users and the Web may change when the level of interactivity changes. Therefore, interactivity level may influence user's evaluation of and attitude towards Web sites.

With the notion of interactivity gaining prominence, several taxonomies of interactivity levels for the electronic medium have been proposed. Hoffman and Novak (1996a) identify two levels of interactivity: machine interactivity at the low end and person interactivity at the high end. Machine interactivity refers to the extent to which users can participate in modifying the form and content of a mediated environment in real time. Person interactivity is defined as interactivity between people that occurs through a medium or is unmediated, as in the case of face-to-face communication. Therefore, machine interactivity is interactivity with the

Table 1
Interactivity scale (based on Kristof and Satran, 1995)

Available control	Example of Interaction	
Control over pace	Click to advance to the next thing	Increasing Level of Interactivity as User Control Increases
Control over sequence	Choose where to go at any time	
Control over media	Start/Stop video; search text; scroll or zoom the view	
Control over variables	Change the outcome of a chart; customize a database search	
Control over transaction	Enter a password; send a message	
Control over objects	Move things around screen	
Control over simulation	Change the perspective of view or the course of action	

medium while people interactivity is the interactivity through the medium. Szuprowicz (1996) further divides machine interactivity into two different levels: user–document interactivity at which level users are not able to influence or manipulate file contents and user-system interactivity at which level users can manipulate the content by changing its characteristics. An example for user–document interactivity is browsing through the hypertext and querying the search engine would be an example of user–system interactivity. At the level of user–user interactivity defined by Szuprowicz (1996), users operate real-time to create response between two or more users. As Szuprowicz (1996) points out, within each of the three major levels, more detailed levels of interactivity may be found. Kristof and Satran (1995) operationalize the extent of interactivity into a seven-level scale (Table 1) based on the kind of control available to users.

3. Research model and hypotheses

3.1. Research model

A review of the Web usability literature could not identify any clear model on Web user attitude formation. Since about 63% of Web users come to commercial Web sites for information and purchasing goods and services (Nielsen, 1999c), research into the attitude towards Web advertising (Ducoffe, 1996) that offers similar functions may provide a good model for studying Web user's attitude and its

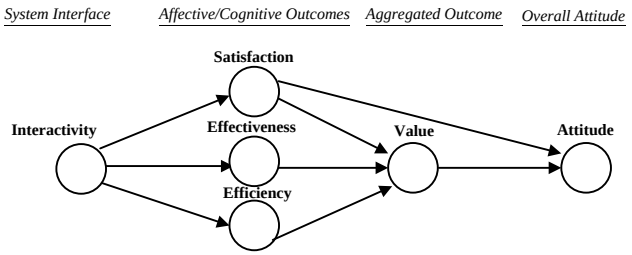


Fig. 1. Research Model

determining factors. Built upon theories on attitude formation (i.e. Rosenberg, 1960), Ducoffe proposes that an individual's attitude is determined by two specific constructs: affect and cognition of value. Affect is measured with entertainment that may lead to feelings of satisfaction. Entertainment is found to influence user's attitude both directly and indirectly through influencing cognition of value. Two other factors influencing cognition of value are informativeness and irritation. Informativeness refers to the ability to effectively provide relevant information. Irritation refers to any offending effects.

However, adjustments to the model constructs may be necessary to better suit our context of a commercial Web site's usability study. Apparently, the three contributing factors proposed in Ducoffe's attitude model are closely related to the three key constructs of system usability: satisfaction, effectiveness and efficiency (Frokjaer et al., 2000). As this research is interested in improving commercial Web sites' usability from a HCI's perspective, these usability-related constructs are used to refine Ducoffe's model. These constructs have been found to be persistent factors influencing Web system usability. Lindenberg and Neerincx (1999) attest the value of these factors for testing usability of Web-based services. Benbunan-Fich (2001) also finds these factors helpful in evaluating the usability of a commercial Web site. As such, effectiveness, efficiency and satisfaction are studied as independent aspect of usability following the recommendations by Frokjaer et al. (2000).

Drawing upon Ducoffe's (1996) model, we posit that the impact of Web site interactivity level on user's attitude is mediated by user's affect [satisfaction] and user's cognition of Web site value (Fig. 1). We extend Ducoffe's model to include interactivity as a key-contributing factor to user's affect and cognition of commercial Web sites' value. In addition, Ducoffe's Web-ad-focused model is adjusted to suit the context of commercial Web site usability study. Instead of entertainment, we use satisfaction to measure user's affective feelings. Many studies have identified satisfaction as one of the most obvious outcomes of increased interactivity (Rafaeli, 1989). Satisfaction measures the affective appeal of commercial Web sites through a sense of involvement, control and affective feelings. Instead of informativeness and irritation, we posit that effectiveness and efficiency are two other major determinants of user's cognition of Web value. Effectiveness measures the effects of interactivity in assisting users to find relevant information. Interactivity has been found to help users effectively find and use the relevant information (Szuprowicz, 1996). Interactivity by

itself does not provide information but helps users in providing relevant and organized information on demand. Efficiency measures a Web site's ability to help users get the required information quickly and easily as well as reduce irritations arising from extra information seeking effort and time. Efficiency is a factor peculiar to Web users as the major irritations from Web sites with poor usability comprise of wasted time and unnecessary traffic (Borges et al., 1997). Interactivity features such as search engines and on-line dialogue facilities will reduce the time and effort in which users find what they want from the Web (Kling, 1994). Fig. 1 presents the research model of the study.

3.2. Research hypotheses

3.2.1. Satisfaction

ISO 9241-11 (1998) defines satisfaction as the user's comfort with and positive attitude towards the use of the system. Rafaeli (1989) identifies satisfaction as one of the most obvious outcomes of increased interactivity. User satisfaction with a Web site is a highly desirable Web design goal as satisfied users may spend a longer time at a Web site, revisit the Web site and may recommend it to others (Zhang and Gisela, 2000). Interactivity is claimed to play an important role in user's satisfaction with their on-line experiences (Kierzkowski et al., 1996). Interactivity is also found to bring satisfaction, sense of fun, acceptance and motivation (Rafaeli, 1989; Szuprowicz, 1996). Zhang and Gisela (2000) report user empowerment in which users have control over their interaction with the Web site as one of the factors that contributes to user satisfaction. Satisfaction may also derive from a sense of community (Ha and James, 1998) and increased sociability (Rafaeli and Sudweeks, 1997) provided by interactive features such as on-line forum and chat. As with the affective feeling from entertainment in Ducoffe's (1996) model, satisfaction may have both cognitive effects (users evaluate a site as better than others) and affective effects (users unconsciously like to visit a certain site) on users. The satisfaction from personal interaction may help maximize users' perceived value of commercial Web sites (Keeney, 1999). Web user may value the sense of community, feeling of connectedness, and increased sociability and consequently form more favourable attitude towards the Web site.

H1a: Increased level of interactivity will result in greater satisfaction.
H1b: Greater satisfaction will result in higher assessment of value.
H1c: Greater satisfaction will result in more favourable attitude towards Web site.

3.2.2. Effectiveness

ISO 9241-11 (1998) defines effectiveness as the accuracy and completeness with which users achieve certain goals. Interactivity is found to bring about effective delivery of available information through engaging users' attention, increasing users' involvement, and enriching users' experiences (Szuprowicz, 1996; Schaffer and Hannafin, 1986). If the relevant information is available on-line, interactivity may

help to deliver them to users more effectively by sieving out irrelevant information for example, using a search engine. Chen and Rada's (1996) meta-analysis indicates that users of hypertext systems tend to have higher effectiveness than users of non-hypertext systems. Hypertext is an example of machine interactivity. With person interactivity, the ability to forge virtual community by interacting with other users through electronic tools such as on-line forum and chat may also help provide more objective information. Ducoffe's (1996) study shows that effectively providing information positively correlates with the value to users. Likewise, Kalakota and Whinston (1996) also note that effectively delivering value-laden content is essential to the Web as a whole. Effectively providing product information is one major factor that can maximize users' perceived value of a commercial Web site (Keeney, 1999). The extent to which a Web site is informative is a critical determining factor of its value (Huizingh, 2000). Many recent studies have also confirmed that the relevance, completeness and timeliness of substantive information are all critical to the Web site visitors (Morris and Turner, 2001). Hence, Web sites with higher effectiveness in delivering information may provide higher value to the users.

H2a: Increased level of interactivity will result in higher effectiveness.
H2b: Higher effectiveness will result in higher assessment of Web value.

3.2.3. *Efficiency*

ISO 9241-11 (1998) defines efficiency as the relation between (1) the accuracy and completeness with which users achieve certain goals and (2) the resources expended to achieving them. One major benefit of interactivity on the Web is enhancing the ability to quickly and easily retrieve relevant information available. Major complaints and irritations from Web sites with poor usability include the enormous amount of time and effort expended in getting information (Borges et al., 1997). Kling (1994) reports that search engines grant easier access to information and help filter information. Site features such as search engines provide consumers with high levels of control and enable them to easily find relevant decision-making information (Hoffman and Novak, 1996a; Morris and Turner, 2001). Through dialogue features such as feedback form and email, Web users can quickly obtain answers to their specific questions and save unnecessary time and effort from browsing vast amount of general information (Ghose and Dou, 1998). Ease of use is another major factor that will maximize user's perceived value of a commercial Web site (Keeney, 1999). Personal relevance that helps increase efficiency of Web use may also account for a large part of perceived value of the Web (Eighmey and McCord, 1998). Hence, higher efficiency experienced in using a Web site may be positively related to a more favorable assessment of the site's value.

H3a: Increased level of interactivity will result in higher efficiency.
H3b: Higher efficiency will result in higher assessment of Web value.

3.2.4. Value and attitude towards Web sites

Users' attitude towards Web sites depends on whether the sites are valuable to them. Consequently, this might be the reason that a Web site's overriding objective is to provide value to its users (Huizingh, 2000). Attitude is shaped through the internalization of value formed through affective and cognitive evaluations (Rokeach, 1972). Many other researchers (Peak, 1955; Tolman, 1951) affirm that the cognitive aspect of a person's attitude may consist largely of expectations about how his values are served through the agency of the attitude object. The importance of value in attitude formation has also been attested in Ducoffe (1996).

H4: Higher assessment of value will result in more favorable attitude towards Web site.

4. Research methodology

4.1. Operationalization of independent variable

The independent variable studied is interactivity level of a Web site. The importance of interactivity level has been articulated by Berthon et al. (1996). Schaffer and Hannafin's (1986) incremental method was used for the experiment where three functional levels of interactivity were offered incrementally (Table 2) based on the extant classifications of interactivity (Hoffman and Novak, 1996a; Szuprowicz, 1996) and interactivity scale (Kristof and Satran, 1995). With this design, any differences between the three groups could be attributed to the increasing levels of interactivity. This approach was also adopted by Burgoon et al. (2000) in their comparison of multiple HCI interfaces with face-to-face interaction.

Table 2
Experimental manipulations of interactivity

Interactivity level	Available features	Type of interactivity	Available control
Low	• Product information	• User–document interactivity	• Control of pace • Control of sequence
Medium	• … • FAQ • Feedback form • Search engine	• … • User–system interactivity • Machine interactivity	• … • Control of media • Control of variables • Control of transaction
High	• … • On-line guestbook • On-line forum • On-line chat	• … • User–user Interactivity • Person interactivity	• … • Control of simulation

"…" denotes elements that are same as those in the lower level.

The system features were selected based on an extensive survey of existing Web usability and electronic commerce literature. They were then classified into differentiating groups as per the level of interactivity they provide. The effects of Frequently Asked Questions (FAQ), feedback form and search engine in improving usability of Web sites were previously reported in Ghose and Dou (1998), Lohse and Spiller (1999) and Palmer (2002). However, to the best of our knowledge, there is no systematic study that examines the usability of on-line forum and on-line chat that offer person interactivity. Each of these two forms of computer-mediated communication tools provides either asynchronous or synchronous computer-mediated communications and has great potential in improving the usability of a Web site.

4.2. Operationalization of dependent variables

The dependent variables studied are five perceptual variables including satisfaction, effectiveness, efficiency, value and attitude towards Web site (Appendix A). Satisfaction was assessed based on three questions taken from Crosby and Stephens (1987) and four additional self-developed questions to include possible satisfaction resulting from active on-line involvement. Features that were reported in other studies that led to user satisfactions were taken into consideration (Chen and Wells, 1999; Zhang and Gisela, 2000). Effectiveness was measured by questions about effective delivery of relevant information to assist decision-making (Cross and Smith, 1996). Efficiency was assessed by questions on both time and effort expended online for decision-making. Value was measured based on three questions taken from Ducoffe (1996) and an additional question about the helpfulness of the site. Attitude was assessed based on three questions from Baker and Churchill (1977). All questions were anchored on a seven-point Likert scale.

Content validity of all items was carefully assessed. First, two scholars with expertise in measurement theory and information systems usability examined the items. Next, the questionnaires with revised items were tested with four postgraduate students who had many years of using commercial Web sites to identify confusing or ambiguous items. After analysing their feedback, a number of minor revisions were made to refine the questionnaire wordings and instructions. Finally, the revised questionnaires were pilot tested with six student volunteers, two for each experimental treatment. Neither technical problems nor manipulation failures occurred during the pilot study. Follow-up interviews with the participants of the pilot test did not indicate any need for substantive changes to the questionnaire.

4.3. Experimental design and procedure

4.3.1. Task and procedure

The usability laboratory testing approach was chosen for its ability to utilize real users as subjects so as to provide detailed insights into specific problems and issues that users face while interacting with target Web site. This is in contrast to usability heuristic evaluation whereby assessments are conducted by a small group of

evaluators against a pre-established set of guidelines (Kantner and Rosenbaum, 1997).

The study was designed as a one-factorial experiment manipulating interactivity levels in the Web design with three groups. Each group had 18 members. The task was to evaluate an on-line store by shopping for a new computer system out of fifteen available systems. As the subject population was information systems major undergraduates, the chosen product class would be relevant and familiar to them. To increase the realism of the task, subjects assumed the role of computer home users who needed to purchase a new computer system. They were asked to browse through the Web site for that purpose, and to evaluate the site. The assumed role with the need to purchase a new computer system helped make the experimental task meaningful and ensured that the subjects would be motivated and involved in conducting the task. The results from our task validity checks revealed that the participants did consider their role and the task performed to be realistic ($M = 5.3$, $S.D. = 0.65$).

The three groups conducted the experiment in three separate but consecutive sessions. The Web site for each session had the same content and design style but different interactivity level. All three Web sites had the same product information and design layout but differed in the types of interactive tools available. Different levels of interactivity were operationalized with incremental interactive components as detailed in Table 2. Each site was made available just before the intended session and was immediately taken offline after the session to exert maximum control over the experiment. The three groups were physically separated throughout the experiment. Each group was first given 5 min to complete a questionnaire measuring their proficiency in using the Web. Then, they were later asked to perform the experimental task without verbal communications with other subjects or facilitation from the administrator within 1 h. No support was given so as to avoid introducing demand characteristics that could confound the treatment effects. Next, manipulation checks were conducted. Manipulation checks were done before the dependent measures were taken to prevent bias formed from responding to the dependent measures (Perdue and Summers's, 1986). The subjects were given 10 min to fill out the manipulation check questionnaire. Subsequently, they were given 15 min to evaluate the site. Finally, they were given 20 min to provide open-ended comments on the interactive features that they used in the experiment. The subjects were also asked whether they intended to buy any of the products from the on-line store and their reasons. The purpose of capturing these responses was not to study purchase intention but to further add realism to the experimental task. We reckon that purchase intention is a complex construct on its own and could be a result of many other considerations such as product quality, price and on-line security, etc. This is beyond the scope of this research that only attempts to investigate attitude towards a Web site.

4.3.2. Subjects

A total of 54 subjects completed the experiment. Subjects were information systems undergraduates and each participated in only one group. They were

randomly assigned into one of three 18-subject groups to control for confounding effects due to differences in subject characteristics. Partial course credits were given to subjects to encourage them to take this study seriously. ANOVA tests found no significant differences for subjects in different treatments in terms of age and experience using the Web. Mann–Whitney tests also found no significant differences in the proportion of male to female subjects across treatments. Controls over subject characteristics through randomization seemed to be successful.

5. Results

5.1. Manipulation and control check

To check the validity of the manipulation of experimental treatments, we used seven-point rating scales to assess the perceived interactivity of each group. A statistical analysis of the results using ANOVA indicated that the three groups were significantly different, $F(2, 51) = 17.08$, $p < 0.005$, $\mathrm{MSE} = 0.605$. A Tukey post-hoc comparison confirmed significant differences between the three groups. The results of this follow-up investigation are presented in Table 3. These tests showed sufficient evidence of effective manipulation between the three different levels of interactivity.

5.2. Partial least-squares analysis

Structural equation modelling approach was adopted in our data analysis, as it possesses many advantages over traditional analyses such as multiple regression. First, it does not involve assumptions of homogeneity in variances and covariances of the dependent variables across groups. Second, it corrects measurement error in the variable measurements. Third, it allows a more complete modelling of theoretical relations compared to traditional analyses of merely associating among measures (Bagozzi and Yi, 1989). Finally, it has the ability to simultaneously test the structural model (i.e. relationships between independent and dependent variables) and the measurement model (i.e. relationships between a latent variable and its indicators). This will provide a more complete analysis for the inter-relationships in the model (Fornell, 1982).

The choice of the variance-based Partial Least Square (PLS) over covariance structure analysis method (e.g. LISREL) was due to the following reasons: (1) PLS

Table 3
Post-hoc analysis presented by mean difference between groups

Group	Low	Medium	High
Low	—	0.806*	1.514*
Medium		—	0.708*
High			—

*Denotes significance at the $p < 0.05$ level.

Table 4
Psychometric properties of the measurement model

Construct indicators	Indicator's loadings	Composite reliability	Average variance extracted
Satisfaction_1	0.749	0.919	0.656
Satisfaction_2	0.758		
Satisfaction_4	0.709		
Satisfaction_5	0.900		
Satisfaction_6	0.888		
Satisfaction_7	0.837		
Effectiveness_1	0.756	0.897	0.746
Effectiveness_2	0.917		
Effectiveness_3	0.909		
Efficiency_1	0.791	0.899	0.689
Efficiency_2	0.812		
Efficiency_3	0.887		
Efficiency_4	0.826		
Value_1	0.839	0.904	0.703
Value_2	0.879		
Value_3	0.758		
Value_4	0.872		
Attitude_1	0.872	0.915	0.782
Attitude_2	0.907		
Attitude_3	0.874		

does not require distributional assumptions; (2) PLS is prediction-oriented and thus gives optimal prediction accuracy (Fornell and Cha, 1994); (3) PLS can be applied to relatively small sample size like ours (Fornell and Bookstein, 1982); (4) PLS technique is appropriate for testing theories in the early stages of development (Fornell and Bookstein, 1982). As our research topic is relatively new, PLS is definitely a more appropriate choice over LISREL (Rivard and Huff, 1988).

5.2.1. Measurement model

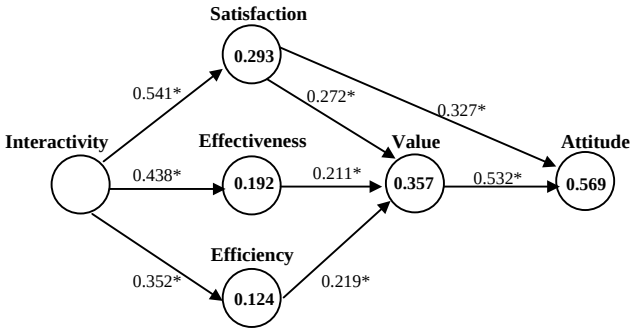
A factor analysis (Table 4), specifying a five-factor solution, on responses to questions in the appendix showed that all the questions measuring each perceptual variable loaded onto a separate factor. All items except factor Satisfaction_3 (with loading of 0.590) had loadings greater than 0.70, suggesting that they explained more than 50% of the variance in the construct, thus satisfying Fornell and Larcker's (1981) criteria for convergent validity. As such, factor Satisfaction_3 was dropped from subsequent analysis. The composite reliability for satisfaction, effectiveness, efficiency, value and attitude were 0.919, 0.897, 0.899, 0.904 and 0.915, respectively. Cronbach's alphas for all dependent variables were greater than 0.8, satisfying Nunnally's (1978) criteria for reliability. The average variance extracted for every factor fulfilled Fornell and Larcker's (1981) accepted value of 0.5. The results of the three convergent validity tests provided evidence for *convergent validity* of the measurement model.

Discriminant validity was next assessed to ensure that a construct differed from other constructs. As per Fornell and Larcker (1981), the correlations between

Table 5
Discriminant validity of constructs

	Satisfaction	Effectiveness	Efficiency	Value	Attitude
Satisfaction	0.656				
Effectiveness	0.316	0.746			
Efficiency	0.318	0.408	0.689		
Value	0.264	0.254	0.257	0.703	
Attitude	0.360	0.107	0.241	0.490	0.782

Diagonal elements are the square root of average variance extracted for each constructs; Off-diagonal elements are inter-construct correlations.



1. * denotes path coefficients significant at the $p<0.005$ level
2. The value in bold is $\boldsymbol{R}^2$ value of the factor in the structural model.

Fig. 2. PLS Structural Model

variables in any two constructs should be lower than the square root of the average variance shared by variables within a construct. As shown in Table 5, the square root of the variance shared between a construct and its measures was greater than the correlations between the construct and any other construct in the model, satisfying Fornell and Larcker's (1981) criteria for discriminant validity. On the whole, acceptable measurement quality was suggested by the appropriate psychometric properties demonstrated by the convergent and discriminant validity tests.

5.2.2. Structural model

Following confirmation of good psychometric properties in the measurement model, the structural model was next examined to assess their explanatory power and the significance of the paths with the PLS test, an implementation of structural equation modelling. Since PLS does not generate an overall goodness-of-fit index, the primary assessment of validity is by examining R^2 and the structural paths (Chwelos et al., 2001). Statistical significance was assessed using the distribution-free approach of jackknifing (Fornell and Barclay, 1983). A 5% level of significance was used for all statistical tests.

The results of the PLS analysis of the research model are presented in Fig. 2. The findings supported all hypotheses at the $p<0.005$ level. T-values for all path

Table 6
Results of hypotheses testing

	Hypothesis (path)	Path coefficient (b)	*t*-Value	Supported
H1a	Interactivity → Satisfaction	0.541	33.583*	Yes
H1b	Satisfaction → Value	0.272	8.239*	Yes
H1c	Satisfaction → Attitude	0.327	7.451*	Yes
H2a	Interactivity → Effectiveness	0.438	18.647*	Yes
H2b	Effectiveness → Value	0.211	5.362*	Yes
H3a	Interactivity → Efficiency	0.352	14.108*	Yes
H3b	Efficiency → Value	0.219	5.633*	Yes
H4	Value → Attitude	0.532	13.609*	Yes

*Denotes significance at the $p < 0.005$ level.

coefficients are statistically significant at the $\alpha = 0.005$ level as shown in Table 6. Approximately 57% of the variance in the attitude towards commercial Web sites was accounted for by the variables in the model [$R^2 = 0.569$]. The path coefficients ranged from 0.211 to 0.541 exceeding the suggested minimum standard of significance at 0.20 (Chin, 1998). Evidently, the fit of the overall model seemed good.

6. Discussion and implications

6.1. Discussion of findings

The interpretation of the results from our casual model could be done in a similar manner as traditional regression analysis. The R^2 value may be interpreted in a similar way as it is done in traditional regression analysis, the path coefficients are equivalent to the standardized beta weights in the multiple regression model. However, the casual model is comparatively stronger since the computation of the path coefficients and variances took into consideration the interactions between all the constructs and causal links within the model. All path coefficients of the causal links in our hypothesized model are significantly strong. The variance explained for each factor indicates that as a group, these predictors are able to explain to a certain extent how interactivity of a commercial Web site affects the user's perceived usability of it.

As hypothesized antecedents of perceived value, the three outcomes of interactivity have comparable path coefficients toward perceived value, implying that the three aspects are almost equally important in forming the perceived value of a Web site. Interactivity level of a Web site appears to have the strongest positive effect on satisfaction ($b = 0.541$). Similar findings have been reported in other studies (Ha and James, 1998; Zhang and Gisela, 2000). It is also noteworthy that the path coefficient of satisfaction to perceived Web site value is the highest among the three Web value antecedents. This suggests that satisfaction may be the largest contributing factor in forming user's perceived Web site value. Interactivity level also appears to positively influence the effectiveness of information delivery on a

Web site ($b = 0.438$). With machine interactivity offered by a search engine, users are able to control and customize the information received. The use of search engine will increase relevance of an information request and result in a higher perceived value of the Web site. Furthermore, with an on-line forum and on-line chat, users have access to independent information from other users. The interactivity levels available appear to significantly influence the Web site's effectiveness to assist users in their decision-making process. Such results reinforce previous findings that interactivity brings about effective delivery of information (Schaffer and Hannafin, 1986; Szuprowicz, 1996). Our findings confirm the positive effects of including FAQ and feedback form. This is consistent with the findings of Lohse and Spiller (1999). Our results also affirm Ducoffe's (1996) findings that effective provision of information contributes to value. Information retrieval efficiency also appears to improve with increased level of interactivity. This is similar to Kling (1994) and Cross and Smith's (1996) findings. However, we observe that efficiency seems to be the factor least affected by changes in the interactivity level ($b = 0.352$) among the three interactivity outcomes under study.

As with the study by Ducoffe (1996), we find that both cognitive elements (value) and affective elements (satisfaction) contribute significantly to attitude formation. Perceived value acts as a strong antecedent to attitude towards Web sites with $b = 0.532$. This implies that higher perceived value of a Web site contributes to the formation of more favourable attitude towards it. Our results echo Wu's (1999) findings that user's attitude towards Web sites is positively related to the perceived interactivity of the Web sites. The access log and observations during the experimental sessions further confirm this. Using the duration time metric proposed by Hoffman and Novak (1996b), we obtain results that indicate a trend where users of more interactive sites tend to spend a longer average time on a single page. Furthermore, users of more interactive sites also tend to register more "hits" which could be another indication of their involved interest. Observations of users' behaviour during the experimental sessions indicate that the longer time spent by users using more interactive sites was not due to confusion or inattention. Subjects of High Interactivity sites showed the greatest interest whereas those of Low Interactivity showed boredom occasionally during the session although the content provided was the same.

However, our findings are not consistent with Bezjian-Avery et al.'s (1998) results that users viewing interactive media advertisement were less interested because they spent less time than those viewing traditional non-interactive advertisement. One possible explanation for the difference may lie in the operationalization of interactivity. In their study, both the interactive and non-interactive conditions ran as parallel advertisements. Such a setting offers a very low level of interactivity with only control over viewing sequence as the same information was provided regardless of what the users clicked. This provides only a minimal sense of control and involvement. On the contrary, our study provided real content on the experimental Web sites, this is fundamentally different from advertisements [experimented in Bezjian-Avery et al.'s (1998) study]. Realistically, most Web users do not go to a Web site to view or interact with ads; they may hence react to real

Table 7
Interactive features found useful

Group	Features found useful by % of subjects in group
Low interactivity	Navigation links—50%
Medium interactivity	Navigation links—19% Feedback form–69%; FAQ—62%; Search engine–58%
High interactivity	Feedback form—33%; FAQ—75%; Search engine—58%; On-line forum—71%; Online chat—63%

contents on the Web site differently from the way they react to Web ads. Our experimental Web site also offered a full range of interactive features that can be tried out fully.

Table 7 shows that increasing level of interactivity may have practical impact on fulfilling users' needs. According to the open-ended comments gathered on the interactive features of the sites, the features that the subjects found to be especially useful were usually the key interactivity features that distinguished that level of interactivity from the lower level. It was also interesting to observe that the availability of FAQ on the Web sites was highly valued by consumers. This could be due to the high informational value of FAQ that provided answers to commonly asked questions. As to the desired interactive features suggested in the open-ended responses, most of the features desired by a lower level group were the additional features provided to the higher-level groups.

Our findings have empirically confirmed the claims of extant literature that increased interactivity level has positive effects on the sense of satisfaction, effectiveness for information delivery, and information retrieval efficiency of Web sites (Kierzkowski et al., 1996; Kling, 1994; Cross and Smith, 1996). Similar to Ducoffe's (1996) study, affective feelings from satisfaction, effectiveness in information delivery and avoidance of irritation through information retrieval efficiency together contribute to users' cognition of value. Our results also confirm Rosenberg's (1960) theory that affective feelings contribute to attitude both directly and indirectly through influencing cognition.

6.2. Implications for practitioners

Our findings suggest positive impacts of interactivity level on Web sites' usability. The option to receive only relevant information in an efficient manner should be provided to Web site users. This can be done through providing search engines and other information filtering mechanisms (Kalakota and Whinston, 1996). Our study has provided support for prior research in confirming the positive effects of user–machine interactivity. More significantly, we give fresh evidence on the enormous potential effects of user–user interactivity. If used appropriately, they are likely to induce positive behavioural outcomes beyond favourable attitude towards a Web site. Our research suggests that interactivity is indeed a process-dependent concept rather than a static attribute-based concept as highlighted in Sohn and Leckenby

(2002). With user–user interactivity incorporated into a Web site, designers need to be aware of the highly dynamic interactions between social and technological factors and how they influence Web site usability. However, practitioners should be cautious not to provide too much interactivity. The level has to be optimized for the constraints of users' neural bandwidth and skills (Hoffman and Novak, 1996a). If too much interactivity is provided than the users can take, it will be unlikely to hold their attention very long. Furthermore, the bandwidth of the infrastructure delivering the interactivity must be taken into consideration to ensure that access speed is not hampered by the increased interactivity.

E-commerce practitioners should also appreciate the dual nature of on-line consumer as both a traditional shopper and a computer user. This means that appropriate interface, navigational structure, and other elements of human–computer interface are as important to retaining customers as good customer service and lower prices for a commercial Web site (Koufaris, 2002). E-commerce merchants should no longer place secondary importance on interface design and Web site features over other product-related factors. In order to better understand on-line consumer behaviour, it is also important to look at the users' interaction with the Web site both as a store and as a system (Koufaris, 2002). This is because the technology incorporated is a key means of interaction with a commercial Web site. In this study, we are concerned specifically with the usability evaluations and value derived from the interaction with a Web-based interface system that only form part of the overall perceived value of commercial Web site to users. Practitioners should be aware that other factors such as Web site's security technology, information privacy polices, product pricing and variety, etc. could also affect overall perceived value of a commercial Web site (Keeney, 1999).

6.3. Limitations

There are several limitations to the current study. In the first place, it employed experimental groups in a laboratory setting. Laboratory experimental study is normally limited by its relatively low external validity, although its internal validity is high. In addition, our one-shot experimental design was also limited in its ability to study usability behaviours over a period of time. Even though our results indicated that the surrogate student subjects were sufficiently engaged in the experimental role and task to provide meaningful response, any attempt to generalize the findings to real settings must be done with caution. Furthermore, although the structured equation modelling technique used was able to handle small samples, more statistical conclusion validity could be achieved with a larger population. Our study specifically examined usability in the context of commercial Web sites. According to ISO's definition, usability is a concept dependent on the context of use, thus the extent to which our findings can be applied to other types of Web sites needs to be revalidated.

6.4. Directions for future research

This research has strengthened the linkage between human–computer interaction, communications and electronic commerce research. We found that the user interface and the mode of interaction mechanisms provided to the users are critical elements for commercial Web sites. Nevertheless, there remain ample opportunities for future work in synthesizing research from these multiple streams (Agarwal and Venkatesh, 2002). Our research has established preliminary evidence about incorporating interactive features to make a Web site more usable. It attested interactivity level's direct impacts on Web user's attitude when relevant contents are already available. Future studies could investigate the interaction effects of interactivity level, Web user's attitude, Web content and content structuring. Fruitful research could also be done to examine other Web design characteristics that may affect Web user's attitude towards commercial Web sites. The structural model in this study could be built upon and enhanced further to study other usability factors. The refinement of the measurement scale is another area that needs more work. The operationalization of constructs is rather specific for commercial Web sites but it could be useful as a basis to develop scales to suit studies for other types of Web sites. The existing study focuses only on the user's attitude, further work could be done to extend the research beyond attitude to explore effects of interactivity on other aspects like purchase intention (Stevenson et al., 2000), customer retention or unplanned purchases (Koufaris, 2002). Lastly, as Agarwal and Venkatesh (2002) point out, there is considerable diversity in the devices through which users can access Web sites, ranging from a cellular telephone to a television set to a personal digital assistant. Hence, a natural progression for the next phase of research is the usability of mobile device interface.

Our study advances a theoretical model to explain commercial Web user's attitude. We have examined the impact of different interactivity level on user's attitude towards commercial Web sites. Specifically, we have provided evidence that the extent of machine interactivity and person interactivity will influence user's attitude towards a Web site. Our results lend empirical support to the prior research findings and design guidelines concerning inclusion of interactivity into Web sites. We believe that the casual modelling of the relationships between different outcomes of interactivity and user attitude has provided insights into Web features desirable in improving commercial Web sites' usability. Research along the direction of this study can certainly contribute significantly to the understanding of how the usability of Web sites could be improved.

Appendix A. Measurement instruments of dependent variables

The following dependent variables are measured on a 1–7 Likert scale where 1 represents strongly disagree, 4 represents neutral, and 7 represents strongly agree.

(I) Satisfaction

1. I felt a strong sense of active involvement.
2. I played a more influential role in the communication process.

3. I feel that I have gained more power over what I can do with the Web site.
4. I had control over what I wanted to do on the Web site.
5. I feel satisfied with my visit to the Web site.
6. I feel pleased with my visit to the Web site.
7. I have a favourable impression of the Web site I have visited.

(II) Effectiveness

1. The Web site increased my awareness of the merits and demerits of the products.
2. The Web site provided me with relevant information to facilitate my decision.
3. The Web site helped me to meet my decision-making need.

(III) Efficiency

1. I could easily search for information.
2. I was able to access the information I needed quickly.
3. I took little effort to find the information I needed.
4. The Web site allowed me to make a decision quickly.

(IV) Value

Please indicate on the scale the extent to which you agree with the adjective that represents your assessment of the *value of* the Web site.

1. not useful 1 2 3 4 5 6 7 useful
2. not important 1 2 3 4 5 6 7 important
3. not helpful 1 2 3 4 5 6 7 helpful
4. worthless 1 2 3 4 5 6 7 valuable

(V) Attitude

Please indicate on the scale the extent to which you agree with the descriptions that match the *attitude* you have towards the Web site.

1. boring 1 2 3 4 5 6 7 interesting
2. not enjoyable 1 2 3 4 5 6 7 enjoyable
3. dislike 1 2 3 4 5 6 7 like

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