Consumer Knowledge of the World Wide Web: Conceptualization and Measurement

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ABSTRACT

User-directed technologies such as the Web are becoming more prevalent. To understand the usage of these technologies the characteristics of users need to be studied. The focus here is on one user characteristic: consumer knowledge content. Based on qualitative and quantitative analyses, four scales are developed to measure common declarative, common procedural, specialized declarative, and specialized procedural knowledge content of the Web. In addition, an illustration is provided to show how these scales might be used for segmenting consumers. The procedures used may be of value in a wide range of studies where the focus is on investigating users of user-directed electronic technologies. © 2004 Wiley Periodicals, Inc.

Consumers are surrounded by an array of electronic technologies. Many of these technologies are user-directed, notably, the Web; touch-based ATMs and e-kiosks; wireless systems such as WAP, iMODE, and SMS; and electronic organizers like Palm Pilots. From a marketing viewpoint, it is important to understand the characteristics of the users of these technologies (e.g., what do they know about the features of these technologies and how to use them?). Armed with answers to these questions,

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it should be easier to refine and augment existing technologies, and design and develop new technologies that are of real value to consumers. Also, communications to inform consumers of the benefits and uses of these technologies might be more effective, resulting in an increased likelihood of adoption and use.

Characteristics of Web users are the focus of this article, with one characteristic of particular interest, namely, consumer knowledge content of the Web. Examples of this characteristic include the information stored in a consumer's memory about how to use a search engine, what cookies are, or the benefits of "what's new" links. Although this is quite a narrow consumer and technical focus, the impact of consumer knowledge on information processing (Alba & Hutchinson, 1987), product evaluations (Cordell, 1997), and the processing of advertising (Maheswaran & Sternthal, 1990) has been well researched. Furthermore, the approach used here is likely to be appropriate for studies of other electronic technologies (WAP, iMODE, SMS, etc.) and other user characteristics (knowledge structure, etc.).

The Web context is discussed first. This is followed by the conceptualization of consumer knowledge. Two well-accepted types of consumer knowledge content are reviewed (declarative and procedural), and two further types are suggested to take account of variations in consumers' familiarity and expertise (common and specialized knowledge). Next, a description of the multi-item scale development and measurement procedures is presented. Finally, the scales are used to assist in the segmentation of Web users.

THE WEB CONTEXT

The Web has become the focus of a considerable amount of research. Early work tended to examine tactical issues, including studies of Website design, button styles, and window placement (Rada, 1995). However, now it is realized that if Web usage is to be properly understood, user characteristics must be investigated as well (Hoffman & Novak, 1996; Peterson & Merino, 2003; Yoh, Damhorst, Sapp, & Laczniak, 2003). This echoes the work of McLuhan (1964), Rice (1984), and Rogers (1986), all of whom saw the need for analyses of the interaction between user characteristics, technology, and technology usage.

For users, there are at least three problems with a user-directed technology like the Web: "lack of closure," "cognitive overhead," and "learning by browsing" (Foss, 1989). Lack of closure arises when the structure and organization of the network is unknown, and thus users do not know the extent of the network, nor the proportion of relevant items that remains to be seen. Second, problems stem from the cognitive demands placed on the user of a hypertext document, hence cognitive overhead. Third, learning by browsing may pose difficulties for the inexperienced, giving

rise to difficulties remembering, consolidating, and understanding the content of a hypertext system.

By way of example, consider the use of graphical browsers to interact with the Web. Browsers rely on highly developed spatial processing skills and as such users have to orientate themselves by visual cues just as when they are walking through a familiar city. Conklin (1987) suggests there is no natural topography for an information space like the Web or specific Web sites, so until a person is familiar with any given layout that person is disoriented. All this requires a more active and changing role for the user compared to the use of simpler electronic technologies like broadcast radio or television.

Given these complexities of both the system and user characteristics, and consequently the many difficulties that arise during Web usage, it is argued that the ability of users to manage these challenges crucially depends on their knowledge and experience of the Web.

CONSUMER KNOWLEDGE

Knowledge is the body of facts and principles (i.e., information and understanding) accumulated by mankind (i.e., stored in memory) about a domain (Delbridge & Bernard, 1998).

A first step in studying knowledge is to examine "knowledge content," that is, the *types* of information stored in consumer memory of a particular domain. Examples of knowledge content include information about the terminology and procedures required for using the Web. Four types of consumer knowledge content are considered here, drawing on literature from the cognitive sciences and marketing. These are declarative and procedural knowledge content, and specialized and common knowledge content. Thus, consumers might not only differ in their knowledge of what search engines are and how to use them, but also by the common and technical knowledge of what search engines are and how to use them. Each of these types is discussed in turn.

It needs to be noted here that having obtained an understanding of knowledge content, it is appropriate to assess the organization and structuring of knowledge (Brucks & Mitchell, 1981; Mitchell, 1981). However, this second step is not part of the current study.

Procedural and Declarative Knowledge Content

In the knowledge literature it is usual to distinguish between declarative and procedural knowledge. Declarative knowledge is defined as "factual information that is somewhat static in nature which is usually describable" (Best, 1989, p. 7); for instance, information about the attributes, terminology, evaluative criteria, facts, and usage situations of the domain of interest (Brucks, 1986). "The Web is slow" is an example of a

factual statement about the Web, whereas "Web sites" and "search engines" are examples of attributes of the Web.

Procedural knowledge, by contrast, refers to the dynamic information underlying skillful actions (Best, 1989, p. 7); that is, the knowledge of rules or procedures for taking action believed to be stored and organized into production systems (Brucks, 1986). Brucks and Mitchell (1981) argue that the basic elements of production systems are condition–action statements, and further refinement by Brucks (1986) suggests that procedural knowledge comprises information about the processes and procedures for domain usage and decision-making. The statement, "to send an e-mail, the send button is clicked" is an example of a condition-action statement, that is, condition (send e-mail) and action (click send button).

Anderson (1983) discussed the impact of these different types of knowledge content on behavior, suggesting that although both types can guide behavior, procedural knowledge content is considered of greater influence on actual behavior. For example, to send an e-mail, knowing "how to send an e-mail" (procedural) will have more influence on final behavior than knowing "what an e-mail is" (declarative).

Although these two terms appear to be precise and definitive, it has been noted that the difference between declarative and procedural knowledge may not always be distinct (Anderson, 1983; Best, 1989; Baddeley, 1991). Indeed, it is easier to draw abstract distinctions between "knowing what" (declarative) and "knowing how" (procedural) than to determine an exact and practical boundary between the two (Best, 1989).

Common and Specialized Knowledge Content

The knowledge literature also distinguishes between experts and novices, and the familiar and unfamiliar (Alba & Hutchinson, 1987). This distinction refers to the amount of knowledge a consumer has learned, the acquisition of specific information, and the mastery of new skills (Baddeley, 1991; Chi, Glaser, & Rees, 1982). As such, this distinction gives rise to two further types of knowledge; namely, common and specialized knowledge.

Specialized Knowledge Content. Conceptual and empirical work shows that the quantity and type of knowledge content a consumer has acquired is a key characteristic that differentiates experts from novices. An expert or specialist has a large body of experience, knowledge, and procedural skill within a domain (Chi et al., 1982; Spence & Brucks, 1997). It is further argued that having expertise is the possession of special skill or knowledge, as trained by practice—thus, it is to be skillful or skilled. In the marketing literature, expertise is seen as the high level of relevant skill and knowledge an individual has to perform product-related tasks successfully (Alba & Hutchinson, 1987). An example is a Web designer who has a level of specialized understanding of the parts of a Web site and of how certain Web-site features work.

Thus, specialized knowledge can be defined as "skilled and/or extraordinary information about a domain of interest required to perform skilled domain-related tasks successfully." It might be assumed, for example, that an expert would have a high level of specialized knowledge and a novice a low level of specialized knowledge.

Common Knowledge Content. Familiarity is another important aspect of knowledge. The familiar is defined as commonly or generally known or seen (Delbridge & Bernard, 1998). In marketing, this might be generally known information about product categories and brands, based on advertising exposure, product purchase/use, and word-of-mouth effects (Alba & Hutchinson, 1987; Johnson & Russo, 1984). In the Web context, a familiar and common element might be a Web page and a familiar or common procedure would be "surfing a Web page."

Hastie (1982) characterizes this as generic or common knowledge—meaning widespread, ordinarily, generally, or publicly known (Delbridge & Bernard, 1998). In the present study common knowledge is defined as "general and/or publicly known information of the domain of interest required to perform general and common domain-related tasks successfully." It is proposed that a consumer's familiarity is therefore based on common knowledge, stored in a consumer's memory.

From this discussion of types of knowledge, the following typology is derived:

- **Common Declarative Knowledge.** General and/or publicly known static information about facts, terms, attributes (what) of a domain required to perform general and common domain-related tasks successfully.
- **Specialized Declarative Knowledge.** Skilled and/or extraordinary static information about facts, terms, attributes (what) about a domain required to perform skilled domain-related tasks successfully.
- **Common Procedural Knowledge.** General and/or publicly known dynamic information underlying skillful actions (how) of a domain required to perform general and common domain-related tasks successfully.
- **Specialized Procedural Knowledge.** Skilled and/or extraordinary dynamic information underlying skillful actions (how) about a domain required to perform skilled domain-related tasks successfully.

This, in turn, provides a basis for classifying consumers as experts, novices, familiar and unfamiliar, and combinations of these (novices/unfamiliar, etc.) (Table 1). For example, a Web-site designer with 10 years of

Table 1. A Typology of Consumer Knowledge.

	Declarative		Procedural	
	High	*Low*	*High*	*Low*
Specialized	Specialized Declarative *(Expert)*	Specialized Declarative *(Novice)*	Specialized Procedural *(Expert)*	Specialized Procedural *(Novice)*
Common	Common Declarative *(Familiar)*	Common Declarative *(Unfamiliar)*	Common Procedural *(Familiar)*	Common Procedural *(Unfamiliar)*

experience might be classified as highly familiar with the Web and a Website expert. By contrast, a school teacher with 5 years of Web usage experience might be classified as highly familiar with the Web, but a novice with respect to his/her specialized knowledge of the Web. These classifications pose distinct differences in a consumer's range of knowledge content about a domain.

METHOD

Operationalization of Consumer Knowledge of the Web

Consumer knowledge of the Web can be measured in various ways. Some of the existing approaches are rudimentary, relying on proxy or subjective measures to infer consumer knowledge. For example, Diaz, Hammond, and McWilliam (1997) differentiated novice and expert users of the Web based on the number of hours on-line. Such measures are widely used by academics and commercially—typically moving very little beyond measures of direct experience (i.e., hours, months, and years that the medium has been used) and "perceived knowledge" of the Web (e.g., "I am extremely skilled at using the Web compared to most users"; Novak, Hoffman, & Yung, 2000).

However, numerous consumer studies reveal a poor correlation between what people think they know, what their experience is, and what is actually stored in memory (e.g., Brucks, 1985; DeNisi & Shaw, 1977; Fischoff, Slovic, & Lichtenstein, 1977; Lichtenstein & Fischoff, 1977; Nelson, Leonesio, Shimamura, & Landwehr, 1982; Park, 1982; Schacter, 1983). The current study develops more reliable and more objective measures of Web knowledge content. Although, as cautioned by Engel, Blackwell, and Miniard (1990), objective measurement of knowledge is "by no means an easy task, given the vast array of relevant knowledge that a consumer may possess."

To make the task manageable, attention is limited to knowledge arising from machine interactivity on the Web. Machine interactivity (MI) is "the extent to which users can participate in modifying the form and content of a mediated environment in real time"; this contrasts with per-

son interactivity (PI), which is "the use of network supported software to enable users to communicate through the medium, such as e-mail and chat" (Hoffman & Novak, 1996; Steuer, 1992). In a study of over 16,000 Internet users, MI activities were identified as the main use of the Web by 65% of respondents (www.consult.com.au, 1999). For example, interacting with the Web to access information (e.g., business 19%, entertainment 11%, academic 8%, news and reference 6%, education 4%, and hobbies 3%), to play games (e.g., 2%), to download software (e.g., 3%) and to complete shopping and electronic transactions (1%). Given MI is documented as one of the key activities undertaken by users, there is much sense in concentrating on this when developing more objective measures. This does not preclude studies concentrating on PI at a future date.

Having narrowed the focus to machine interactivity, there then follows a two-phase procedure. A qualitative phase is used to generate items and make an initial assessment of content validity. There then follows a quantitative phase for scale development and validation.

Qualitative Phase: Item Generation and Content Validity

The item-generation process involved a number of qualitative steps. First, a set of free-response items was constructed on the basis of the typology developed by Brucks and Mitchell (1981) and later refined by Brucks (1985) and Brucks (1986). Second, input came from a panel of Web designers and marketing experts—they were able to comment on those aspects of the Web that are required or used for Web navigation (i.e., terminology, attributes, facts, evaluative criteria, usage situations). Third, information was obtained from an observational study of novice users, from Web-site and help-file content analyses, and from in-depth interviews with experienced and inexperienced users. Steps 2 and 3 are summarized in Table 2, and the characteristics of the expert panel are shown in Table 3.

On the basis of these qualitative steps, items were generated and their content validity assessed. Initially, a pool of 110 items was developed to measure consumer knowledge of Web attributes, terminology, facts, evaluative criteria, usage procedures, benefits, and condition-action statements for Web navigation. The panel of experts was asked to rate all 110 items on two separate occasions to ensure that the items tested demonstrated content validity and reflected the four types of Web knowledge content. The purpose of the first round of ratings was to group items as measuring either declarative or procedural knowledge content, and the goal of the second round of ratings was to group items as measuring either specialized or common knowledge of the Web. Items with 70% or more agreement across the experts on either occasion were retained for further testing. Nine items were deleted because categorization could not be agreed upon across the panel.

A final set of items was derived, consisting of 31 items measuring common declarative knowledge (e.g., "what is a search engine?"), 29 items measuring specialized declarative knowledge (e.g., "what is a Boolean

Table 2. Establishing Content Validity.

Type	Research Design	Sample
Expert survey	Web-based open-ended	Perceived industry & academic experts ($n = 12$)
Observation	Disguised observation of novice "web use" training	$2 \times$ evening community college courses ($n = 15$)
Content analysis (1)	Web site attribute and content analysis	Top 20 "most accessed" Web sites by Australian users in January 1999 (5 pages)
Content analysis (2)	Web site attribute and content analysis	Top 20 "most accessed" Web sites by Australian users in January 2000 (5 pages)
Content analysis (3)	Web browser help files content analysis	Netscape Communicator Microsoft Explorer ($n = 2$)
In-depth interviews	Semi-structured	Task completion & verbalization ($n = 5$)

search operator?"), 13 items measuring common procedural knowledge (e.g., "how do I use a search engine?"), and 19 items measuring specialized procedural knowledge content of the Web (e.g., "how do I use a Boolean search operator?").

Quantitative Phase: Scale Development and Validity

For the main quantitative phase of scale development and validation, four independent samples were recruited. These were drawn from one postgraduate and three undergraduate university student groups who were carefully selected to ensure there would be variance in respondents' knowledge of the Web (Table 4). Thus, the Communications sample was expected to have moderate/high levels of knowledge; by contrast the Education and Science samples were expected to have low/moderate levels of knowledge. The Marketing sample was expected to be diverse, with low/moderate/high levels of knowledge.

Table 3. Expert Panel Characteristics.

Area of Expertise	No. of Experts	Experience (Yrs.)
Cognitive/knowledge researcher (academic)	3	5–10
Human/consumer researcher (academic)	2	10–15
System usability researcher (academic)	1	10
Web site designer (practitioner)	4	6–8
System usability & design manager (practitioner)	2	10–15

Table 4. Sample Frame—Independent Student Groups.

#	Program	Discipline (Subject)	EKL	Sample	Response	Useable	Admin.
1	Postgrad. (masters)	Marketing: Elements of marketing	L/M/H	70	24	24	Take home
2	Undergrad. (first yr.)	Science: Conservation, biology & biodensity	L/M	63	57	48	In class
3	Undergrad. (third yr.)	Communications: New technology A	M/H	100	33	31	Take home
4	Undergrad. (first yr.)	Education: Educational psychology	L/M	64	55	50	In class

EKL = Expected Knowledge Level (L = Low, M = Moderate, H = High).

Survey Instrument

The survey instrument was administered in paper format to increase access to novice as well as expert users and to reduce the chances of perceptual bias (a potential problem if the study had been conducted on the Web). Some 297 surveys were administered with 153 useable responses (52% response rate).

All items from the qualitative phase were presented to respondents. Response formats were a mix of five-category multiple-choice questions and three-category true/false/don't know questions. The "don't know" option was included to increase the chances of measuring actual knowledge as opposed to the respondent's ability to guess correctly. These items were recoded to correct/incorrect, with "don't know" classified as "incorrect" in line with respondents' own admission of "no knowledge" (following Park, Mothersbaugh, & Feick, 1994).

Sample Characteristics

The goal was to have variance with regard to Web knowledge, but for the samples to be broadly similar in other respects, allowing pooling of the data. Cross-tabulations confirmed this. For all items measuring actual Web knowledge there was variance in the data, with the four samples behaving as expected (i.e., the Communications sample showed moderate/high levels of knowledge, Education and Science were low/moderate, and Marketing was low/moderate/high).

In most other respects, the individual samples were comparable (based on a visual comparison of descriptive variables). Therefore, it was deemed appropriate to pool the data. The combined sample was 69% female and 31% male, with 75% of respondents less than 24 years of age. With regard to respondents' computer experience, 13% of the sample had less than 2 years' computer experience, 18% had 3–4 years, 29% had 5–6 years, and 40% had 7 or more years. With respect to Web experience, 22% had been

using the Web for between 6 and 11 months, 30% between 1 and 2 years, and 39% between 3 and 4 years.

SCALE DEVELOPMENT AND VALIDATION

For the four scales developed, a principal-components factor model with varimax rotation was used. With a sample size of 153 cases, only factor loadings of +/– 0.45 and above were considered significant (Hair, Anderson, Tatham, & Black, 1995, p. 385). Reliability analyses were also performed on all four scales to check for internal consistency, with items deleted if the corrected item–total correlation fell below 0.5.

The question then arises of whether the constructs are uni- or multidimensional. As with any factor analysis, there is no exact quantitative basis for deciding the number of dimensions to extract. A standard latent root criterion was used here, where only those dimensions with initial eigenvalues of at least 1 were retained. In two cases this resulted in unidimensional constructs. Given prior theory, this was not unexpected. Moreover, this approach has the advantage of greatly simplifying subsequent analyses. However, the latent root criterion tends to be quite conservative, and therefore, for completeness, results are also presented based on the percentage of variance criterion (Hair et al., 1995, pp. 377–379). It is suggested that in some subsequent analyses it may be informative to work with the greater number of dimensions that this criterion generates. In the following sections, each scale is discussed in turn. The final list of items is shown in Appendix 1.

Common Declarative Knowledge of the Web

Initial data screening and analysis of the correlation pattern showed that 28 of the 31 items for common declarative knowledge individually and collectively met the necessary threshold of sampling adequacy for factor-analytical investigations (KMO Measure of Sampling Adequacy = 0.840, Bartlett's test of sphericity: approx. chi-square = 1381.676, df = 378, Sig. = 0.000). These 28 items were reduced to 10 items in accordance with reported factor loadings and an assessment of internal consistency (explaining 57% of the variance with a reliability of 0.9).

With the use of a latent root criterion, common declarative knowledge proved to be unidimensional. The dimension was comprised of five items with factor loadings 0.534–0.742 (explaining 30% of the variance with a reliability of 0.8). This was labeled "Web Standards," because it consists of items relating to common declarative information about Web standards (e.g., commonly known facts about standards for domain names, Web addresses, and hyperlinks). If the percentage of variance is considered too, it is possible to extract a second dimension. This was comprised

of five items, with factor loadings 0.540–0.793 (explaining 27% of the variance with a reliability score of 0.8). This was labeled "Web Tools and Terminology," as items relate to common declarative information about Web tools and terminology (e.g., favorites or bookmarks, and navigation bars and search engines).

Specialized Declarative Knowledge of the Web

For the items measuring specialized declarative knowledge of the Web, 4 of the 29 items had MSA levels of less than 0.50. These items were omitted, producing a higher level of sampling adequacy for this construct (KMO measure of sampling adequacy = 0.819, Bartlett's test of sphericity: approx. chi-square = 536.658, $df = 55$, Sig. = 0.000). Thus, a reduced set of 25 items collectively and individually met the necessary threshold of sampling adequacy. Based on factor loadings, these items were further reduced to 11 items (explaining 59% of the variance with a reliability of 0.9).

These 11 items measure three dimensions—one dimension is well above the latent root threshold, whereas the other two dimensions sit on and just below the threshold. Dimension 1 was comprised of five items with factor loadings 0.603–0.791 (explaining 24% of the variance with a reliability of 0.8). This was labeled "Web Tools and Terminology," as items refer to specialized declarative information about Web tools and terminology (e.g., plug-ins, Boolean operators, and metacrawlers). Dimension 2 was comprised of four items with factor loadings 0.509–0.686 (explaining 19% of the variance with a reliability score of 0.6). This was labeled "Web Standards," as items relate to specialized declarative information about Web standards (e.g., standard encryption methods and standard terms for information transfer on the Web). Dimension 3 was comprised of two items with factor loadings 0.706–0.834 (explaining 16% of the variance with a correlation of 0.7). This was labeled "Web Cookies," with items describing specialized declarative information about Web cookies.

Common Procedural Web Knowledge

Initial data screening and analysis of correlation patterns identified that individually and collectively all 13 items met the necessary threshold of sampling adequacy (KMO measure of sampling adequacy = 0.723, Bartlett's test of sphericity: approx. chi-square = 410.173, $df = 78$, Sig. = 0.000). These 13 items were then reduced to 6 items, based on an assessment of factor loading and internal consistency (explaining 75% of the variance with a total reliability of 0.8).

This is a uni-dimensional construct, if the latent root criterion is the sole basis of assessment. This dimension was comprised of three items with factor loadings 0.666–0.819 (explaining 31% of the variance with a reliability of 0.7). This was labeled "Speed of Web Use," because it

refers to common procedural information about how to improve the speed of Web use (e.g., by typing a correct Web address or using bookmarks and favorites). Taking account of percentage of variance, it might be argued two further dimensions exist. Dimension 2 was comprised of two items with factor loadings 0.686 and 0.888 (explaining 26% of the variance with a correlation of 0.7). This was labeled "Web Features," because items relate to procedural information about how common features of the Web work or benefit the user. Dimension 3—a very marginal case—was comprised of 1 item, with a factor loading of 0.968 (explaining 18% of the variance). This was labeled "Site Changes/Updates," as the item focuses on common procedural information about the benefits of Web-site updates.

Specialized Procedural Web Knowledge

Initial data screening and analysis of correlation patterns identified 1 of the 19 items measuring specialized procedural knowledge had an MSA level lower than 0.50. This item was removed, resulting in the remaining 18 items collectively and individually meeting the necessary threshold of sampling adequacy (KMO measure of sampling adequacy = 0.832, Bartlett's test of sphericity: approx. chi-square = 814.871, $df = 153$, Sig. = 0.000). These 18 items were reduced to a final 11 items (explaining 58% of the variance with a reliability of 0.8).

These 11 items measure three dimensions—two dimensions are well above the latent root threshold, whereas the other is just below the threshold. The first dimension was comprised of four items with factor loadings 0.564–0.790 (explaining 21% of the variance with a reliability of 0.7). This was labeled "Web Features." It refers to specialized procedural information about how features of the Web work (e.g., "Hyperlinks," "Search Engine Queries," and "URLs"). Dimension 2 was comprised of three items with factor loadings 0.714–0.809 (explaining 20% of the variance with a reliability score of 0.7). This was labeled "Speed of Web Use," as items loading on this factor deal with specialized procedural information about how to improve the speed of Web use (e.g., "purging your cache file" and "auto load images option"). Dimension 3 was comprised of four items with factor loadings 0.500–0.853 (explaining 18% of the variance with a reliability score of 0.7). This was labeled "Quality of Web Use." It focuses on specialized procedural information about how to improve the quality or effectiveness of Web use (e.g., items related to effective search-engine queries and browser features).

Respondent Knowledge Content of the Web

Because scales to measure the four constructs have been developed, it is possible to use them for segmentation purposes. The preceding section

has shown that at least some constructs are multidimensional, and therefore further analyses should be conducted at the level of these dimensions. However, for illustrative purposes (and because the sample is not particularly large) the scale items for each construct were grouped together and treated as unidimensional.

For each type of consumer knowledge content, respondents are partitioned into three levels—low, medium, and high. This shows the sample as a whole has greater common knowledge of the Web than specialized knowledge. Specifically, 42% of the sample had a high level of common declarative knowledge, 44% had a high level of common procedural knowledge, whereas 42% had moderate levels of specialized procedural knowledge, and 59% had low levels of specialized declarative knowledge. Furthermore, the sample overall had higher levels of procedural information than declarative information stored in their memories. This reflects the interactive, user-directed, and experiential nature of the Web—under these conditions it is easier for users to acquire knowledge of how to use the Web than to understand what Web features and facilities are.

Disaggregating across the sample, a large percentage of respondents from the Communications subsample showed high levels of knowledge across all four types (Table 5). For instance, 81% showed high levels of common procedural knowledge. This is consistent with expectations—given the greater exposure of Communications students to the Web. At the other end of the scale, many more respondents from Education displayed low levels of knowledge of the Web. For instance, 40% showed low levels of common procedural knowledge. This too is in line with expectations for these subsamples. Between-group ANOVAs show that all these differences between subsamples are statistically significant (e.g., the large number who have high common procedural knowledge in the Communications subsample is significantly different from the small number who have common procedural knowledge in the Education sample).

Table 5. Levels of Knowledge for Each Knowledge Type in Each Subsample.

	Marketing Sample (%)			Science Sample (%)			Communications Sample (%)			Education Sample (%)		
	L	*M*	*H*	*L*	*M*	*H*	*L*	*M*	*H*	*L*	*M*	*H*
Common declarative	8	42	**50**	31	33	36	0	16	**84**	**46**	36	18
Specialized declarative	**63**	25	12	**73**	19	8	22	23	**55**	**68**	28	4
Common procedural	13	25	**62**	**38**	29	33	3	16	**81**	**40**	36	24
Specialized procedural	25	**46**	29	25	44	31	0	32	**68**	42	**44**	14

Knowledge levels: L = Low, M = Moderate, and H = High.

For each knowledge type in each subsample, the highest percentages are shown in bold.

CONCLUSION

In the context of machine interactivity (MI) on the Web, scales have been developed to measure four types of consumer knowledge content of the Web. These scales distinguish between common declarative knowledge, specialized declarative knowledge, specialized procedural knowledge, and common procedural knowledge. This, in turn, provides a more objective means of classifying and segmenting users based on the knowledge of the Web they have stored in their memories.

This approach contrasts with some of the proxies used in previous academic and commercial research. Many of these proxies are purely experienced based, and often a poor correlation has been found between consumer experiences and what is stored in the memories of consumers (e.g., DeNisi & Shaw, 1977, and earlier references). Some support for this claim is found here, with fairly low positive correlations between the four different types of consumer knowledge content and both the length of computer use and length of Web use (Table 6). Despite the simplicity of the proxy measures, the results here support previous work in the knowledge literature—namely, that although experience and usage have some relationship to knowledge stored in an individual's memory, they are not adequate proxy measures on their own.

From a managerial perspective, these scales offer some promising applications. For example, results might provide insights into the adoption, disadoption, and nonadoption of user-directed and highly complex technological developments (e.g., e-commerce) and Web behavior (e.g., information search, on-line shopping, on-line selling). Furthermore, they could provide additional guidance for system development and network design to improve consumer use and navigation of these systems.

However, further refinement and validation of the scales would be appropriate, for example, through the use of Web-based survey instruments and other elicitation techniques (especially for tapping into procedural knowledge). Also, once scales for knowledge content have been obtained, it is important to go on to examine the structure and organization of Web knowledge (Brucks & Mitchell, 1981; Mitchell, 1981).

Table 6. Correlation between Consumer Knowledge Content Type and Web Use.

	Length of Computer Use	Length of Web Use
Common declarative	.395**	.464**
Specialized declarative	.273**	.377**
Common procedural	.347**	.337**
Specialized procedural	.351**	.348**
Length of computer use	—	.552**

** $p < 0.01$.

Another extension would be to widen the sample base. For this study, subsamples were chosen to ensure variability across the various types of knowledge content, but the question remains as to how other samples might score with the use of the scales developed here. The qualitative phase highlights the vast range of experience levels among users, from novices attending a Level 1 course on surfing the net to Web-site designers. An on-line survey of a much broader cross section of Web users confirms the usefulness of the approach described here (Page, 2003).

In addition, it is believed that the principles used here would extend to other examples of user-directed systems, giving studies such as this wider applicability than may at first appear to be the case. One extension would be to look at person interactivity (PI) with the Web, to complement the focus here on machine interactivity (MI) (Steuer, 1992). Another natural extension would be to look at consumer knowledge of other user-driven electronic technologies, including touch-screen electronic kiosks and ATMs; wireless system technologies such as WAP, iMODE, and SMS; and electronic organizers like Palm Pilots. The specific content of the scale items will change across these applications—as indeed they might change over time for Web usage itself—but the underlying distinctions between knowledge types are likely to persist.

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APPENDIX 1: CONSUMER KNOWLEDGE CONTENT OF THE WEB: SCALE ITEMS

Common Declarative Web Knowledge Content

1 A web address can sometimes contain spaces between the characters.
2 The length of time it takes a page to appear on the screen: a) depends on the speed of your modem-server connection; b) is aggravated by pages with lots of pictures; c) is associated with the term bandwidth; d) all of the above; e) don't know.
3 Which of the following is NOT a domain example: a) .gov = government; b) .net = network; c) .mil = military; d) .hme = home; e) don't know.
4 A domain name is the security key required to read encrypted information.
5 Hyperlinks are clickable text and graphics that connect web pages.
6 Favorites or bookmarks are a facility used to store web addresses for later use.
7 FAQ is an important site feature as it provides answers to the more common user questions.
8 Navigation bars and search engines can assist efficient site navigation.
9 Downloading is the transfer of files or software to your computer from a network.
10 The security indicator on a program used to access the web shows whether a document is secure or insecure.

Web Standards = Items 1–5; Web Tools & Terminology = Items 6–10

Specialized Declarative Web Knowledge Content

1 "Boolean Operators" are technologies developed to link web pages.
2 Bandwidth is only an issue for old computers connected to the Internet.
3 Boolean logic is a system of logical thought used to narrow search queries.
4 Meta-crawlers search multiple search engines to retrieve a comprehensive list of search results.
5 An external application used to display non-web standard files while using the web is: a) a banner ad; b) a plug-in; c) a server; d) an ISP; e) don't know.
6 Bandwidth is the amount of information that can be transferred over the web.
7 DES is the standardized encryption method used on the web.
8 Digital signatures and digital watermarks help ensure the authenticity of documents on the web.
9 A server is a computer software program used to access the web.
10 Cookies are small pieces of information that are read from your computer.
11 Cookies are data files stored on your computer to activate computer viruses.

Web Tools & Terms = Items 1–5; Web Standards = Items 6–9; Web Cookies = Items 10-11

Common Procedural Web Knowledge Content

1 Typing a correct web address in the URL location field and pressing enter will take you directly to the web page specified.
2 You cannot open multiple windows at the same time to use the web.
3 Bookmarks & favorites are great tools for creating shortcuts to web pages.
4 The icon in the top right-hand corner of your screen animates when a connection is in progress.
5 Using search engines properly enables faster access to information,
6 A benefit of "What's New" links is that they display a page about the most current changes or updates on a web site.

Speed of Web Use = Items 1–3; Web Features = Items 4–5; Site Changes & Updates = Item 6

Specialized Procedural Web Knowledge Content

1 Textual links sometimes change color when you have previously selected that link.
2 The change of a mouse pointer to a hand indicates that the text or graphics pointed to are links.
3 A URL is how web pages or web sites are located on the web.

4 To increase the number of search results from a search engine query, "or" is used between the words searched for.
5 After viewing a web page on the screen, it may be placed in cache temporarily.
6 To speed up your computer you should purge your cache file regularly.
7 Web pages are displayed faster by turning on the auto-load images preference on your web access software.
8 By pressing reload you will ask your computer to disconnect your connection to the Internet.
9 The following search engine query: Sydney + Sport – Olympics would retrieve search results just about the Sydney Olympics.
10 To be randomly sent to any page on the web you should click the 'forward' button.
11 By putting (AND) or (&) between words in a search engine query, the results retrieved will contain both words searched for.

Web Features = Items 1–4; Speed of Web Use = Items 5–7; Quality of Use = Item 8–11