Evaluating information accessibility and community adaptivity features for sustaining virtual learning communities

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Abstract

Virtual communities have been identified as the “killer applications” on the Internet Information Superhighway. Their impact is increasingly pervasive, with activities ranging from the economic and marketing to the social and educational. Despite their popularity, little is understood as to what factors contribute to the sustainability of virtual communities. This study focuses on a specific type of virtual communities—the virtual learning communities. It employs an experiment to examine the impact of two critical issues in system design—information accessibility and community adaptivity—on the sustainability of virtual learning communities. Adopting an extended Technology Acceptance Model, the experiment exposed 69 subjects to six different virtual learning communities differentiated by two levels of information accessibility and three levels of community adaptivity, solicited their feelings and perceptions, and measured their intentions to use the virtual learning communities. Results indicate that both information accessibility and community adaptivity have significant effects on user perceptions and behavioural intention. Implications for theory and practice are drawn and discussed.

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Keywords: Virtual learning community; Community sustainability; Information accessibility; Community adaptivity; Technology acceptance model; Sense of belonging

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1. Introduction

The latest buzzword on the Internet Information Superhighway appears to be “community”. Recently, several high-profile Internet companies such as Yahoo and Excite have launched clubs and communities to encourage users to form special interest groups around topics ranging from “stamp collecting” to “parenting” (Napoli, 1998). Virtual communities are so popular that these have been called the “killer applications” on the Internet (Napoli, 1998). Their impact is increasingly pervasive, with activities ranging from the economic and marketing to the social and educational. They have also been touted to facilitate organizational learning of skills, expertise and experiences through people interacting with one another and accessing a common repository. Owing to the growing importance of virtual communities, organizations and researchers have been spending much money and effort to research how these communities could be harnessed to achieve organizational goals and to examine the impact of virtual communities on Internet users (e.g. Rheingold, 1993; Turkle, 1995; Wellman and Gulia, 1995; Oldenburg, 1997). They are also actively building virtual communities to provide and share information, form social networks, promote brand loyalty, facilitate purchase decisions and ensure stickiness to lure advertisers, marketers and Internet users.

Universities and schools of different levels have also initiated virtual learning communities, to encourage newer forms of learning, where technology is used for more active, interactive and collaborative learning, whether in a distance learning or classroom-based environment (Scardamalia and Bereiter, 1994; Brown and Campione, 1995; Bielaczyc and Collins, 1999; Khosrow-Pour, 2002).

Unfortunately, little is understood as to what factors are critical to the sustainability of virtual learning communities. Given the critical roles of virtual learning communities today, it is of paramount importance that we understand the critical success factors of building virtual learning communities and what should be done to ensure their sustainability. Without understanding the desirable features that Internet users want of a virtual learning community, it would be difficult for organizations and individuals to realize the benefits of this new form of learning.

This study seeks to fill this gap in the literature by identifying two critical system design issues that could potentially influence the sustainability of virtual learning communities. These design issues are information accessibility and community adaptivity. An experiment is conducted to assess the effects of information accessibility and community adaptivity on the sustainability of a virtual learning community. Our focus is on virtual learning communities where groups of students can communicate, and have a focal point (such as a website) to congregate virtually for some learning purposes. In contrast, the scenario of many solitary students surfing the web and keeping their own notes will not count as a virtual community.

This paper is organized as follows: Section 2 reviews the key literature on virtual communities; Section 3 discusses the theoretical foundations used for this study and presents a research model based on the Technology Acceptance Model (TAM);
Section 4 details the research methodology used in this study; Section 5 describes the statistical techniques and presents the results of hypotheses testing and Section 6 discusses the findings, draws implications for further research and practice and summarizes the key contributions of this study.

2. Virtual community

Since the early stage of Internet development, researchers and academics have used computer networks to form their own communities. Recent advances in World Wide Web technologies and tools—particularly those that lead to cheaper and faster communication, the integration of various devices and platforms and the processing of multilingual text—have made it increasingly easier for interested parties to organize virtual communities.

Virtual communities are defined as social relationship aggregations that emerge on the Internet when enough people carry out public discussions long enough, with sufficient human feelings (Rheingold, 1993). They should also meet the following criteria: shared goals and ideals, some degree of stability, growth, loyalty and commitment by their members (Falk, 1995). Current virtual communities, such as www.yahoo.com (a community with many special interest groups, such as Yahoo! Personals and Yahoo! Careers), www.ebay.com (a community of buyers and sellers), www.oracle.com (a community of Oracle users and developers), provide varying levels of core services. Some offer free personal web pages and special interest topic hosting at their core while others have electronic mail (email), chat room and bulletin board services at their core. More sophisticated virtual communities allow members to hold personal conferences or provide moderators to manage discussion sessions. Activities in virtual communities thus range from chatting, making friends, exchanging ideas, and sharing knowledge on a particular subject, to conducting business transactions. All these electronic interactions enable new communities on the Internet (Igbaria, 1999).

The interest in virtual communities could be partly attributed to the benefits and opportunities for both individuals and online businesses. Virtual communities enable individuals to interact easily with others across time and space, and thereby to collaborate or simply to acquire information and knowledge (Igbaria et al., 1998). Virtual communities have also been helpful emotionally, such as in sharing pain from illness or loss, and fostering religious fellowships (Chervokas and Watson, 1997; Preece, 1998). Members also cultivate intimate relationships among themselves—something that may not be easily done in the physical world. These benefits enhance an individual's self-worth, sense of belonging and overall level of happiness (Mynatt et al., 1998). Virtual learning communities can also enhance learning through collaboration (Scardamalia and Bereiter, 1994; Bruckman, 1997; Looi, 1998; Ang et al., 1999). Sustaining a community may have economic benefits too. For online retailers, buyers who return spend more than one-time buyers. A survey conducted by Binary Compass Enterprises showed that repeat customers
spent almost twice as much as first time customers, $251 versus $127 (Binary Compass Enterprises, 1998).

Virtual communities are fraught with problems too. One central issue is the control of accessibility to information in a virtual community. To-date, almost every virtual community has certain barriers of entry that prevent some participants from accessing the full range of services or information available on the site (Valtersson, 1996). For example, www.talkcity.com requires users to sign in (and thus become a registered user) before they can participate in chat rooms, create a club or create a homepage. The registration process is a form of barrier, as it involves some costs, such as some potential loss of individual privacy. Some virtual communities introduce monetary cost in their registration as well. For example, at www.wizardworld.com and www.webshot.com, fee-paying registered members have access to more features than nonfee-paying registered members.

Such barriers of entry may have limiting effect on membership, leading to less interactions, less appealing features, and may eventually cause the demise of the virtual community. Participants are sometimes provided with either too much or too little information. While too little information may render the virtual community useless to individuals, too much information can make it difficult for them to find what they want. This information overload problem is often compounded by the absence of proper information organization (Finholt and Sproull, 1990; Barua et al., 1996).

Even more disconcerting is the failure of virtual communities to adapt to user needs when providing information (Davenport, 1997). While novice users may be satisfied with the so-called standard services offered, more experienced users are asking for customized information. Experienced users are also asking to be actively involved in virtual-community-building by means such as defining new structures, discussion threads and chat rooms, and inviting new participants. For example, GeoCities (geocities.yahoo.com) allows users to create personal websites, domains, subdomains, groups of email messages, as well as setting security on webpages. Tripod (www.tripod.lycos.com) also provides many tools and features that users can learn and use in their community-building and participation. Users who are keen on seeking out the interactivity of the medium do not like to be constrained by a fixed way of doing things. Mynatt et al. (1998) suggested that organizers of virtual communities should learn and adapt services to suit changing needs to stay relevant.

The problems highlighted suggest two critical system design issues: information accessibility and community adaptivity. Information accessibility refers to the type and amount of information organized in a way that is accessible to participants. The paradox of information, where too little serves no purpose and too much causes information overload, suggests that this is an important design issue. Community adaptivity of a virtual community refers to the extent to which its members and its system could adapt the rules, the structures and the information content to suit their needs. Community adaptivity allows members to gain greater control. Overall, these two factors may play critical roles in sustaining a virtual community.
3. Conceptual foundations and hypotheses

3.1. Research model for sustainability of virtual learning communities

Our review of the virtual learning community literature has not yielded any clear model on virtual learning community sustainability. A virtual learning community is undergirded by an information system that offers its services and features for use by members of the community. Adoption and use of the underlying information system constitute the fundamental notions of a virtual community’s sustainability (Kollock, 1998). Thus, a virtual community is sustained if its members (or new members) adopt and use the information system definitive of that community. For example, the virtual community of eBay sellers and buyers is sustained when a sufficient number of members adopt and use the eBay website to look for information and carry out transactions.

The TAM has been widely used in the study of the adoption and use of information systems in many different environments (Davis, 1989; Gefen and Straub, 2000; Lederer et al., 2000; Venkatesh and Davis, 2000). TAM has also been widely used in studies on traditional information systems (e.g. Wiedenbeck and Davis, 1997) as well as Internet systems (e.g. Lin and Lu, 2000). It is thus a good model to turn to for studying the adoption and use of a virtual community website, i.e. the sustainability of a virtual community. Built primarily on the theory of reasoned action (Fishbein and Azjen, 1975), expectancy theory (Robey, 1979; Vroom, 1964), and efficacy theory (Bandura, 1977), TAM theorizes that an individual’s behavioural intention to use a system is determined by two specific belief constructs: perceived usefulness and perceived ease of use, and that perceived usefulness is also influenced by perceived ease of use, because other things being equal, the easier the system is to use, the more useful it can be (Davis, 1989). TAM further theorizes that the effects of external variables (e.g. systems characteristics, training) on behavioural intention to use are mediated by perceived usefulness and perceived ease of use.

Drawing on the TAM model, we posit that the impact of a virtual learning community’s system characteristics (information accessibility and community adaptivity) on participants’ intention to use is mediated by the perceived usefulness and perceived ease of use that participants have of the community. However, unlike the traditional TAM model, our extended TAM model of virtual community sustainability includes sense of belonging as a mediating variable between perceived usefulness and intention to use, and between perceived ease of use and intention to use. Sense of belonging is a factor peculiar to virtual community, and is important to the extent that no involvement or participation would be forthcoming from users if it is lacking in them (Roberts, 1998). Perceived usefulness and perceived ease of use should enhance participants’ sense of belonging because a useless and difficult to use system would severely dent participants’ interest in the activities of the virtual learning community. Thus, besides perceived usefulness and perceived ease of use, sense of belonging should also influence intention to use.
Fig. 1 shows the extended TAM model of virtual learning community sustainability. This model follows a similar approach by Lin and Lu (2000) and Venkatesh and Davis (2000). Citing DeLone and McLean (1992), they also studied system quality (in the forms of information quality, response time and system accessibility) as an independent group of factors affecting perceived usefulness and perceived ease of use. This was done in the context of a news website. System quality in the form of output quality has also been studied as a factor affecting perceived usefulness by Venkatesh and Davis (2000).

3.2. Information accessibility effects

Perceived accessibility has been a critical factor affecting information system use and success (Culnan, 1984; Rice and Shook, 1988). The concept of accessibility includes four dimensions: terminal accessibility, information accessibility, system reliability and ease of learning the control language (Culnan, 1984; Rice and Shook, 1988). This study focuses on information accessibility, which is defined as the type and amount of information, and the cohesiveness of information organization assigned to the participants.

Several studies have shown that higher information accessibility leads to higher usage of information and higher perceptions of ease of use (Higgins and King, 1981; Biehal and Chakravarti, 1986; Wyer and Srull, 1986; Lin and Lu, 2000). In the setting of a news website, the quality of information was found to have a positive effect on perceived usefulness (Lin and Lu, 2000). Information diversity was a factor found related to higher usage of information and higher user contribution level (Rafaeli and LaRose, 1993).

For virtual learning communities, communication channels form a major component of information accessibility. Besides email, which may be directed at specific persons, examples of communication channels are bulletin boards and chat rooms, where students can share information and ask specific questions without directing them at any specific persons. Communication channels allow students “to exchange emotional support, information, and foster a sense of belonging” (Hiltz and Wellman, 1997, p. 44). Participants with low information accessibility would
have limited access to the communication channels and reap few of the benefits that the channels bring.

Besides communication channels, information accessibility in other forms have also been found to be important in virtual learning communities. For instance, Chan et al. (2000) found that students with low audio and visual information have low perceptions of the system’s attractiveness and usefulness, and the social presence of other parties.

Regardless of the form that it takes, information accessibility has been found to be an important factor in virtual learning communities. Ang et al. (1999) suggested in their research model that studies of virtual learning communities should include information accessibility as an important factor. Mynatt et al. (1998) noted that multiple technical and information possibilities in a virtual learning community should increase usage of the virtual learning community. With a wide array of information and services provided on Blacksburg Electronic Village, residents of the virtual community felt more connected (Chervokas and Watson, 1997). Access level has been observed to affect the choice and use of an information system (Swanson, 1987). In a similar vein, higher information accessibility through greater information access and proper information organization, should frustrate users less, and hence lead to higher perceptions of ease of use (Lin and Lu, 2000). In light of these findings, we hypothesize that:

H1a Information accessibility of the virtual learning community has a positive effect on the perceived usefulness of the community.

H1b Information accessibility of the virtual learning community has a positive effect on the perceived ease of use of the community.

3.3. Community adaptivity effects

For a social system to have improved outcomes, its structures should be adapted continuously but in a stable manner to suit the needs of the tasks and the group (Poole and DeSanctis, 1990). In the context of a communication system, Poole and DeSanctis (1989) noted that the social system outcomes, the group’s contextual structures and the technological structures evolve over time in cyclical interactions between institutionalized practices and individual human actions. Structures refer to the goals, rules and resources people use in interactions, and social systems are the outcomes of the application of these structures. Social system outcomes reflect the manner in which groups appropriate the structures of the technology and the context. Appropriation refers to the manner in which these structures are adapted by a group through the interaction processes. This is similar to the concept of structuration, which refers to the process of production and reproduction of social systems via the application of generative rules and resources over time and space (Giddens, 1984).

Hence, the duality of structures is manifested in the structuration process: structures are both the media and outcomes of interactions. Indeed, the duality of structures is the main source of continuities in social reproduction across time and
space. The process of structuration thus accounts for the stability of these structural features as well as for their changes (Poole and DeSanctis, 1989). The fact that structuration occurs in interaction means that users may change or control this process (Poole and DeSanctis, 1989).

In our research context, structuration theory is interpreted as an adaptive process that guides the continuity and reproduction of virtual communities. As in any community, a virtual community’s structural features should be continuously adapted to suit user needs and preferences. A virtual community could tailor its behaviour to a specific user or a user group right from its inception (design phase changes), or it could adapt its behaviour at run-time (Hook, 1997). Systems that adapt to users automatically based on the assessment about the users’ needs are called adaptive systems (Oppermann, 1994). With so many diverse information services and interests among users of a virtual community, it is important that adaptive features allow users to change system parameters to suit their purposes. An intelligent system with an adaptive interface can keep track of user activities and profiles so as to generate dynamically the needed services and information (e.g. Semeraro et al., 2001). We will define a new term, community adaptivity, which is more than interface adaptivity. Community adaptivity is the ability of users and systems to change the rules, structures and content of a virtual community.

Community adaptivity plays an important role in influencing the character of a virtual community, including its success or failure (Mynatt et al., 1998). Warf (1994) posited that social relations are fundamentally affected by the way individuals acquire, store, process and transmit information. Flexible system features that facilitate navigation and the retrieval of appropriate information have been shown to affect willingness to use, and perceptions of ease of use and usefulness (Culnan, 1984). Indeed, when a virtual learning community system is adapted to the needs of an individual (by the system, the individual, and other members of the community), it would make it more efficient and effective for that individual to access the services and information of the system, freeing him of the effort to perform repetitious or otherwise time-consuming tasks whenever he uses the system.

DeSanctis et al. (1993) suggested that adaptive functions should promote greater user participation. Virtual communities with high community adaptivity would be able to attract more members since firms that can adapt to customer demands and requests have higher productivity and customer satisfaction (Daugherty et al., 1995). Suler (1996) argued that since it is not possible to meet every user need within a single virtual community, community adaptivity should enhance the perceived usefulness and perceived ease of use of the virtual community among members of similar interests (i.e. sub-groups within a virtual community). Community adaptivity includes the changing of interface design and features, such as the provision of search facilities, tracking and navigation aids, and the managing of favourite topics; adaptivity also includes the creation and customization of personal website and content. These features and member webpages, besides enhancing the usefulness of the community, should also enable greater ease in retrieving and providing information. For example, Yahoo! GeoCities provides users with a choice of personal-website-building features, including the choice of resources to use, and
whether to have a search function on their sites. In light of these findings, we hypothesize that:

**H2a** Community adaptivity of the virtual learning community has a positive effect on the perceived usefulness of the community.

**H2b** Community adaptivity of the virtual learning community has a positive effect on the perceived ease of use of the community.

### 3.4. Traditional TAM effects

As proposed in the original TAM model (Davis, 1989; Venkatesh and Davis, 2000), the effects among perceived usefulness, perceived ease of use, and intention to use are hypothesized as follows:

**H3a** Perceived ease of use of the virtual learning community has a positive effect on the perceived usefulness of the community.

**H3b** Perceived usefulness of the virtual learning community has a positive effect on intention to use.

**H3c** Perceived ease of use of the virtual learning community has a positive effect on intention to use.

Perceived usefulness is defined as “the extent to which a person believes that using the system will enhance his or her job performance”, and perceived ease of use is defined as “the extent to which a person believes that using the system will be free of effort” (Venkatesh and Davis, 2000, p. 187). These are key variables for predicting intention to use a system (Davis et al., 1989; Mathieson, 1991). Their effects on intention to use have been studied in numerous settings, e.g. in an educational environment (Tan and Chan, 1998), in a news website (Lin and Lu, 2000), in a work-related web (Lederer et al., 2000), and many other situations. Generally, TAM explains about 40 per cent of the variance in usage intention (Venkatesh and Davis, 2000). The sustainability of a virtual community is shown in the members’ adoption and use of the information system (or website) for the community. It is appropriate to test TAM for a virtual learning community setting, and this will add to TAM’s broad applicability.

### 3.5. Sense of belonging effects

A factor peculiar to virtual learning communities, and not present in traditional software, is sense of belonging. Sense of belonging is important and has been used as a test for the presence of an online community (Roberts, 1998). It is considered a very important factor for participation in the community (Tinto, 1993). While sense of belonging may be better studied over a long period of time, it has also been measured in short experiments, and in virtual settings. For example, Williams et al. (2000) measured sense of belonging for subjects who participated in a short online experimental session and Scagnoli (2001) found that a short orientation of students
in distance learning courses can help enhance their sense of belonging. Enhancing sense of belonging should encourage usage. For example, it was reported that “accounting portals and Internet services ... seek profits by giving users a sense of belonging” (Alexander, 2000). In a study of college students, Hagerty et al. (1996) found sense of belonging a useful concept for studying involvement in community activities.

A sense of belonging grows from active participation and experience (Wilkinson et al., 1998). The process of interaction is considered a key factor for fostering a sense of belonging (Rovai, 2002). A system with low ease of use will discourage users from trying the system. On the other hand, a system with high ease of use will encourage greater participation and a higher sense of belonging. Similarly, a useful system encourages more exploration and greater participation in the system, and should lead to a higher sense of belonging. In addition, having a common goal is considered a key aspect of a community (Rovai, 2002). A useful system allows members to achieve common goals (such as learning common topics in a module). A higher sense of belonging is achieved when through effective learning at the common website, members “feel that their educational needs are being satisfied through active participation in the community” (Rovai, 2002). It is thus postulated that perceived usefulness and perceived ease of use would have effects on the participants’ sense of belonging. Finally, a high sense of belonging is expected to lead to greater intention to be further involved in the community. Roberts (1998) reported that subjects with a higher sense of belonging put in more time and effort in their online participation, and Tinto (1993) reported that students with a strong sense of belonging are less likely to drop out of schools. It is hypothesized that:

H4a Perceived usefulness of the virtual learning community has a positive effect on sense of belonging.

H4b Perceived ease of use of the virtual learning community has a positive effect on sense of belonging.

H4c Sense of belonging to the virtual learning community has a positive effect on intention to use.

4. Research methodology

4.1. Research setting

An experiment was carried out to evaluate the effects of information accessibility and community adaptivity on virtual learning community sustainability. The experiment used a 2 × 3 factorial design (see Table 1). Information accessibility was set at two levels—high and low; and community adaptivity was set at three levels—none, static and run-time. Six virtual learning communities corresponding to the treatments were built. These served as virtual places for students, lecturers and tutors of a discrete mathematics course to discuss course topics, gather and disseminate course information, exchange opinions and concerns, and socialize.
Information (e.g. course notes, tutorial questions, class participation marks, past examination questions, hints, mailing lists) together with a set of communication technologies (e.g. email, bulletin boards, real-time chat) and functionalities (e.g. personal web page creation, favourite topic creation) were integrated into the virtual learning communities.

4.2. Operationalization of variables

Because the experiment involved genuine students who were taking the course for credit and hence required a realistic setting, information accessibility and community adaptivity were manipulated on a set of features. Hence, based on Barua et al. (1996) and Herr et al. (1991), information accessibility was operationalized by varying the amount and type of information and through varying the operations and dynamic linking capabilities at two levels. High information accessibility was implemented through easy and structured access to greater amount and variety of information. Low information accessibility was implemented through difficult and unstructured access to less amount and variety of information. Users with high information accessibility could gain access to all available public and private information; they could use dynamic linking capabilities to cross-reference information and traverse between different sections of the community without difficulty; they could post their own information within the virtual learning community; and they could use email, bulletin board and real-time chat to post messages and receive immediate feedback. Users with low information accessibility could only gain access to public information and use email to communicate with others. Table 2 shows the operationalization of information accessibility.

In considering how systems interact with user groups, Hook (1997) presented different levels of adaptivity. For example, the system can be tailored by the user or the system can adjust itself during run-time. Similarly, we operationalized community adaptivity by adjusting the interaction and interface features at three levels: no adaptivity, static adaptivity and run-time adaptivity. Virtual communities with no adaptivity are just information warehouses with standard browser interfaces. Users of virtual communities with static adaptivity could use search facilities and navigating aids and customize their own personal web pages. However, all these

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Table 1
Experimental design in phase one

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No adaptivity</th>
<th>Static adaptivity</th>
<th>Run-time adaptivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low information accessibility</td>
<td>Ten subjects</td>
<td>Eleven subjects</td>
<td>Twelve subjects</td>
</tr>
<tr>
<td></td>
<td>(4 females, 6 males)</td>
<td>(4 females, 7 males)</td>
<td>(5 females, 7 males)</td>
</tr>
<tr>
<td>High information accessibility</td>
<td>Fourteen subjects</td>
<td>Twelve subjects</td>
<td>Ten subjects</td>
</tr>
<tr>
<td></td>
<td>(5 females, 9 males)</td>
<td>(5 females, 7 males)</td>
<td>(4 females, 6 males)</td>
</tr>
</tbody>
</table>

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1The level of information and sophistication of communication technologies and functionalities in each virtual community vary according to the intended treatments.
features are defined in the design phase. Virtual communities with run-time adaptivity could track user activities and adapt their behaviour at run-time to suit user preferences based on the collected profiles. Users at this level could also build their own favourite topics and manage their own preferences in the virtual community. Table 3 presents the operationalization of community adaptivity.

In the overall design, users in the high accessibility and run-time adaptivity group were given access to all information with dynamic text linking features, and all communication channels, and were provided with all run-time adaptivity features. In contrast, users in the low accessibility and no adaptivity group had access to only email and limited information (e.g. no past examination questions and discussions) with no dynamic text linking features, and had zero adaptivity features.

Measures for perceived usefulness of the virtual learning community were adapted from Davis et al. (1989). Perceived usefulness of the virtual learning community was measured by asking subjects to indicate if they found the virtual learning community useful in enhancing their understanding of the course, improving communication among students and between students and course instructors and satisfying their social needs. Perceived ease of use with the virtual learning community was measured in terms of the ease of use with the application’s features and functionalities. From the original questions in Davis et al. (1989), adaptations were made to refer to the specific system and functions used in the experiment.

Measures for sense of belonging to a virtual learning community were adapted from Chin et al. (1996). Sense of belonging to the virtual learning community was

Table 2
Operationalization of information accessibility

<table>
<thead>
<tr>
<th></th>
<th>Low accessibility</th>
<th>High accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of information</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>Type of information</td>
<td>Public information</td>
<td>All data</td>
</tr>
<tr>
<td>Information organization</td>
<td>No dynamic linking capabilities</td>
<td>Dynamic linking capabilities</td>
</tr>
<tr>
<td>Operations on information</td>
<td>Selective read and write</td>
<td>Read and write</td>
</tr>
<tr>
<td>Immediate feedback</td>
<td>No (email only)</td>
<td>Yes (all channels)</td>
</tr>
</tbody>
</table>

Table 3
Operationalization of community adaptivity

<table>
<thead>
<tr>
<th></th>
<th>No adaptivity</th>
<th>Static adaptivity</th>
<th>Run-time adaptivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search facilities</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Navigating aids</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Tracking users’ activities</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Dynamic HTML generation</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Building one’s favourite topics</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Managing one’s favourites</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Customizing one’s homepage</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
assessed by asking subjects to indicate if they felt a strong sense of being part of the community, trust in the community, enjoyment as a result of being part of the community, commitment to the community and high morale among members of the community. Sense of belonging to the community affects social relations which in turn is likely to influence the continuity of the community (Warf, 1994; Mynatt et al., 1998). Hence, it is an important variable for study.

Based on Ajzen and Fishbein (1980), we measured intention to use by asking subjects to indicate whether they were seriously contemplating to return (to use the virtual learning community), whether they believed it was worthwhile and whether they were likely to return. Intention to use has been found a reliable indicator of actual behaviour (Davis et al., 1989) and is hence a good surrogate measure of sustainability. TAM explains about 40 per cent of actual usage (Venkatesh and Davis, 2000). The experiment reported does not cover actual long-term usage, and thus does not measure actual sustainability per se.

4.3. Research subjects

All students (totalling 84 freshmen) of a course were recruited and randomly assigned to six treatment groups in Phase One. Sixty-nine subjects turned up for the experiment. On average, they were 21 years of age (Mean = 20.91, s.d. = 2.04), 61 per cent were males and 39 per cent were females. All had some experience in using a browser but none had any prior experience in virtual learning community participation.

Age (Suler, 1996), gender (Bruckman, 1996), personality (King, 1996) and web-browsing efficacy (Godwin, 1995) have been suggested as potential variables that could contribute to different perceptions and usage in virtual learning community. Using only freshmen from the same computing faculty allowed us to limit subjects to a small age range. In addition, all subjects had sufficient web-browsing efficacy to participate in the virtual community. A control check was performed by analysing responses from all subjects on their level of web-browsing efficacy. No significant differences were detected across treatment groups. Gender and personality differences (e.g. Introversion, Extroversion, etc.) were controlled through randomization. To avoid researcher bias, the same administrator was also used throughout the experiment (Cook and Campbell, 1979).

4.4. Experiment procedure

A pilot experiment was conducted to test the experimental procedure, evaluate the clarity and appropriateness of the information, and to test the interface and interaction features on the virtual learning communities. The pilot subjects were second-year students who had completed the course. Their familiarity with the course was important for their judgment of the information about the course. Based on the feedback, minor adjustments were made to some information available to the virtual learning communities.
In the experiment, six sessions, each corresponding to a different treatment, were conducted. Prior to each session, subjects were briefed on the purpose of the experiment, they were asked to register themselves in their respective virtual learning communities and were allowed to familiarize themselves with the structures and features of their respective information systems for 10 min. No computer training was provided as subjects had computing skills acquired through other courses. They were told that marks would be awarded based on their contributions to the virtual learning community. They were assured that their responses to the survey questions had no effect on their course grades. This served as an incentive for them to participate seriously and truthfully.

The subjects were given a set of seven tutorial problems and were asked to solve three that they were most interested in by browsing through the available information and holding discussion with others in the virtual learning community. At the end of the session, they were to send their answers to their tutors via email. This approach was taken for two reasons. First, it allowed subjects with run-time adaptivity to exercise their discretion in building their own favourite topics and preferences. Second, there was not enough time to fully discuss all seven questions through the virtual learning community. Subjects were encouraged to present their viewpoints and pose questions on their virtual learning communities, as they would normally do in a physical tutorial classroom discussion. They were told that these activities and their answers would be logged to facilitate the tutor in awarding participation marks. The subjects were separated by partitions and no vocal discussion was allowed.

Following the introduction, the subjects accessed the virtual learning community for information to the problems they were most interested in, contacted similarly interested participants through the bulletin board, email and/or real-time chat and built favourite topics and discussion groups (depending on the availability of features in their respective treatment groups). The subjects belonging to run-time adaptivity treatment groups were told in advance they had to log off after 25 min and log on again so that the web site could be customized according to their preferences. After searching for information and discourse with others in their virtual learning communities, the subjects submitted their answers to the tutor via email at the end of the session. All sessions lasted for 1 h 20 min. Subjects were then asked to complete a questionnaire that solicited their feelings and attitudes toward their virtual learning communities. All measures were taken at the end of the experiment.

5. Data analyses and results

Partial least squares (PLS) is an advanced second-generation statistical method that allows optimal empirical assessment of a structural (theoretical) model together with its measurement model (Wold, 1982). The structural model is a network of causal (dependence) relationships linking the model constructs while the measurement model specifies the indicators for each construct, and assesses the reliability of each construct for estimating the dependence relationships. Unlike traditional
regression analyses and factor analysis, PLS addresses both structural and measurement models at the same time. Factor analysis assesses the measurement model only and path analysis addresses the structural model alone. PLS is more prediction-oriented and seeks to maximize the variance explained in constructs. It also does not depend on having multivariate normality, interval scales, or a large sample size.

We selected PLS for data analyses because of the use of noninterval scales, the absence of multivariate normality, and the small sample size. PLS has been applied in information systems as well as in other disciplines (e.g. marketing and organizational behaviour). Indeed, many prior studies in information systems have used PLS to test early versions of theoretical models (e.g. Igbaria et al., 1998). In this study, PLS Graph version 2.91 (Chin, 1994) was used. All statistical tests were conducted at 5-per cent level of significance. Manipulation checks were first performed prior to assessing the measurement and the structural models.

5.1. Manipulation check

Despite controlling for extraneous variables, it is also prudent to ensure that our manipulation of information accessibility and community adaptivity was successful. This was done through checking that the subjects in different groups had different perceptions on the factors that were manipulated. For the information accessibility variable, subjects were asked how they felt about the adequacy, relevancy, presentation and ease of access of information on their virtual learning communities. For the community adaptivity variable, subjects were asked whether their virtual learning communities catered to their personal preferences, whether they had control over their virtual learning communities and to what extent their virtual learning communities adapted their behaviours to their preferences and needs. Manipulation check on information accessibility was conducted by averaging the scores of these questions for each subject and performing a one-way analysis of variance on the averaged scores for high and low information accessibility. Manipulation check for community adaptivity was similarly performed. Significant effects were detected for both information accessibility (F(1,68) = 8.965, p < 0.05) and community adaptivity (F(2,67) = 18.707, p < 0.05) variables. A Tukey-Kramer HSD test applied to compare all pairs for the three levels of adaptivity showed significant differences for all pairs. The results suggest that the experiment was successfully manipulated.

Because we had conceived the virtual learning communities and experimental task on our own, we took it on ourselves to ensure that there was adequate task validity to draw meaningful inferences from the results. Task validity was first and foremost checked by observing the subjects during the session and by examining the log file for any “small talk” or peripheral discussions unrelated to the experimental task. We noted that the subjects were intensely involved; only very few instances of “small talk” were detected in the log files. Moreover, a Student t-test comparing the subjects’ responses to questions on whether the experiment task was meaningful and involving, against the neutral value of 4 showed a high degree of task validity (t = 2.124, p < 0.05).
The strength of the measurement model can be demonstrated through measures of convergent and discriminant validity (Hair et al., 1998). Convergent validity is the degree to which two or more items measuring the same construct agree while discriminant validity is the degree to which items differentiate between constructs, or measure different constructs (Cook and Campbell, 1979). Convergent validity is normally assessed using three tests: indicator (item) reliability, composite reliability of constructs and the average variance extracted by constructs (Fornell and Larcker, 1981). Discriminant validity is assessed by comparing the squared correlations between two constructs (shared variances) with the average variance extracted for all constructs. All multiple-item constructs were subjected to tests of convergent and discriminant validity. Table 4 presents the indicator loadings, Cronbach’s alpha, composite reliability, and average variance extracted. Cronbach’s alpha is included as an additional measure of convergent validity. Table 5 presents the correlation matrix of the constructs and the average variances extracted along the diagonals.

All the constructs demonstrate strong convergent validity. For item reliability, all indicators except perceived usefulness 03 have loadings greater than 0.707, suggesting that they explain more than 50 per cent of the variance in the construct.

---

**Table 4**

Convergent validity of constructs

<table>
<thead>
<tr>
<th>Construct indicators</th>
<th>Indicators’ loadings</th>
<th>Composite reliability</th>
<th>Average variance extracted</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived usefulness 01</td>
<td>0.844</td>
<td>0.826</td>
<td>0.614</td>
<td>0.722</td>
</tr>
<tr>
<td>Perceived usefulness 02</td>
<td>0.719</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived usefulness 03a</td>
<td>0.588</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived usefulness 04</td>
<td>0.782</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived ease of use 01</td>
<td>0.849</td>
<td>0.893</td>
<td>0.721</td>
<td>0.814</td>
</tr>
<tr>
<td>Perceived ease of use 02</td>
<td>0.869</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived ease of use 03</td>
<td>0.829</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sense of belonging 01</td>
<td>0.888</td>
<td>0.932</td>
<td>0.733</td>
<td>0.912</td>
</tr>
<tr>
<td>Sense of belonging 02</td>
<td>0.860</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sense of belonging 03</td>
<td>0.897</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sense of belonging 04</td>
<td>0.854</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sense of belonging 05</td>
<td>0.775</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intention to return 01</td>
<td>0.905</td>
<td>0.880</td>
<td>0.708</td>
<td>0.793</td>
</tr>
<tr>
<td>Intention to return 02</td>
<td>0.894</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intention to return 03</td>
<td>0.709</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*aThis item was culled from the perceived usefulness construct. The composite reliability, average variance extracted, and the Cronbach’s alpha for that construct were computed without this particular item.

5.2. Measurement model

The strength of the measurement model can be demonstrated through measures of convergent and discriminant validity (Hair et al., 1998). Convergent validity is the degree to which two or more items measuring the same construct agree while discriminant validity is the degree to which items differentiate between constructs, or measure different constructs (Cook and Campbell, 1979). Convergent validity is normally assessed using three tests: indicator (item) reliability, composite reliability of constructs and the average variance extracted by constructs (Fornell and Larcker, 1981). Discriminant validity is assessed by comparing the squared correlations between two constructs (shared variances) with the average variance extracted for all constructs. All multiple-item constructs were subjected to tests of convergent and discriminant validity. Table 4 presents the indicator loadings, Cronbach’s alpha, composite reliability, and average variance extracted. Cronbach’s alpha is included as an additional measure of convergent validity. Table 5 presents the correlation matrix of the constructs and the average variances extracted along the diagonals.

All the constructs demonstrate strong convergent validity. For item reliability, all indicators except perceived usefulness 03 have loadings greater than 0.707, suggesting that they explain more than 50 per cent of the variance in the construct.

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2 Composite reliability is computed as \((\sum \text{Std loadings}_j)^2/[(\sum \text{Std loadings}_j)^2 + \Sigma \varepsilon_j]\).

3 Average varianced extracted is computed as \((\sum \text{Std loadings}_j^2)/[(\sum \text{Std loadings}_j^2) + \Sigma \varepsilon_j]\).
The errant perceived usefulness indicator was hence culled from the instrument. The composite reliability and the Cronbach’s alpha of all the constructs were well above the recommended score of 0.7 (Nunnally, 1978), indicating that they have adequate reliability. Every construct also has an average variance extracted exceeding the criterion score of 0.5 (Fornell and Larcker, 1981), suggesting that the amount of variance in the items attributable to errors is less than the amount attributable to the construct.

Discriminant validity was assessed by comparing the squared correlations between constructs and the average variance extracted for a construct (Fornell and Larcker, 1981). A rule for assessing discriminant validity requires that the square root of average variance extracted be larger than the correlations between constructs (see diagonal versus nondiagonal elements in Table 5). All constructs met this requirement. As another measure of discriminant validity, factor analyses were also performed to assess if the indicators discriminate correctly by loading onto its intended factors. All constructs demonstrate adequate discriminant validity.

5.3. Structural model

Following confirmation of good psychometric properties in the measurement model, the structural model was examined to assess the explanatory power of the constructs and the significance of the paths. Hypotheses testing were performed by examining the size, the sign, and the significance of path coefficients in the structural model generated using a jack-knifing technique (Hair et al., 1998). Jack-knifing is a distribution-free technique used to produce parameter estimates, standard errors, and t-statistics. PLS also requires at least a sample size of ten times the largest number of independent constructs affecting an endogenous variable to avoid biasing the results toward higher estimates for indicator loadings at the expense of lower estimates for path coefficients. Our PLS analyses fulfilled this requirement. Since PLS does not generate an overall goodness of fit index, one primarily assesses validity by examining the $R^2$ of the endogenous constructs and the structural paths.

Table 5
Discriminant validity of constructs (square root of average variance extracted along diagonals)

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Information accessibility</td>
<td>SI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Community adaptivity</td>
<td>0.105</td>
<td>SI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Perceived usefulness</td>
<td>0.333</td>
<td>0.665</td>
<td>0.784</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Perceived ease of use</td>
<td>0.275</td>
<td>0.664</td>
<td>0.610</td>
<td>0.849</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Sense of belonging</td>
<td>0.384</td>
<td>0.594</td>
<td>0.666</td>
<td>0.663</td>
<td>0.856</td>
<td></td>
</tr>
<tr>
<td>6. Intention</td>
<td>0.283</td>
<td>0.553</td>
<td>0.668</td>
<td>0.555</td>
<td>0.668</td>
<td>0.839</td>
</tr>
</tbody>
</table>

SI: Single item (manipulated) construct.

The errant perceived usefulness indicator was hence culled from the instrument. The composite reliability and the Cronbach’s alpha of all the constructs were well above the recommended score of 0.7 (Nunnally, 1978), indicating that they have adequate reliability. Every construct also has an average variance extracted exceeding the criterion score of 0.5 (Fornell and Larcker, 1981), suggesting that the amount of variance in the items attributable to errors is less than the amount attributable to the construct.

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4Results of factor analyses were not included due to space constraints. They can be furnished upon requests.
Fig. 2 illustrates the results of the PLS analyses and Table 6 presents the descriptive statistics of the dependent measures. Except Hypotheses 3a and 3c, all hypotheses were significant in the desired direction at the 1-per cent level of significance. The size of the significant path coefficients ranges from 0.360 to 0.701. Community adaptivity has a stronger effect than information accessibility on both perceived usefulness and perceived ease of use. Information accessibility and community adaptivity together account for 61 and 56 per cent of the variance in perceived usefulness and perceived ease of use, respectively.

Perceived ease of use was found not to have significant effects on perceived usefulness (contradicting Hypothesis 3a) and on intention to use (contradicting Hypothesis 3c). In TAM application to more traditional software, perceived ease of use usually has smaller effects than perceived usefulness (Venkatesh and Davis, 2000). This smaller effect of perceived ease of use was also observed for web systems (Lederer et al., 2000). It seems that for virtual learning community systems, the addition of sense of belonging redirects all the effects of perceived ease of use into this new factor.

** : p < 0.01  *: p < 0.05

Fig. 2. Path coefficients, t-statistics and $R^2$ of research model (**, p < 0.01; *, p < 0.05).

Table 6
Mean (s.d.) of dependent measures by treatment

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Community adaptivity</th>
<th>Perceived usefulness</th>
<th>Perceived ease of use</th>
<th>Sense of belonging</th>
<th>Intention to use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information accessibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>No</td>
<td>3.70 (0.79)</td>
<td>3.53 (0.57)</td>
<td>3.32 (0.88)</td>
<td>4.13 (1.20)</td>
</tr>
<tr>
<td>Low</td>
<td>Static</td>
<td>4.55 (0.40)</td>
<td>4.40 (0.53)</td>
<td>4.56 (0.74)</td>
<td>5.12 (0.50)</td>
</tr>
<tr>
<td>Low</td>
<td>Run-time</td>
<td>5.17 (0.80)</td>
<td>5.03 (0.59)</td>
<td>5.30 (0.63)</td>
<td>5.61 (0.51)</td>
</tr>
<tr>
<td>High</td>
<td>No</td>
<td>4.86 (0.28)</td>
<td>4.21 (0.56)</td>
<td>4.73 (0.53)</td>
<td>5.02 (0.61)</td>
</tr>
<tr>
<td>High</td>
<td>Static</td>
<td>5.58 (0.38)</td>
<td>4.81 (0.89)</td>
<td>5.22 (0.59)</td>
<td>5.61 (0.48)</td>
</tr>
<tr>
<td>High</td>
<td>Run-time</td>
<td>5.54 (0.65)</td>
<td>5.80 (0.32)</td>
<td>5.78 (0.37)</td>
<td>6.07 (0.31)</td>
</tr>
</tbody>
</table>
Perceived usefulness and perceived ease of use in turn account for 55 per cent of the variance in sense of belonging. Together with sense of belonging, they explain 54 per cent of the variance in intention to use. Sense of belonging appears to be an important addition to the TAM for the study of virtual learning communities, as important as perceived usefulness. As evident in these results, the structural model possesses strong validity since the majority of the structural paths are significant and all endogenous constructs have relatively high $R^2$.

To double check that demographic variables are not significant factors in influencing the endogenous variables, we conducted further PLS analyses for age and web-browsing efficacy by splitting the dataset into two subsets using their median values. Results for each subset were no different from the overall results. Similar PLS analyses were also performed for gender, which again yielded similar results for male and female subsets compared to the overall results. Hence, we conclude that controls for these variables through randomization were satisfactory.

5.4. Further analyses

To detect possible interaction effects between information accessibility and community adaptivity on perceived usefulness and perceived ease of use, the dataset was divided into two subsets based on low and high information accessibility and subjected to PLS analyses. Fig. 3 presents the results of the PLS analyses on the split samples. Existence of interaction effects was assessed by statistically comparing the path coefficients from community adaptivity to perceived usefulness and from community adaptivity to perceived ease of use in the low information accessibility structural model to the corresponding path coefficients in the high information accessibility structural model. The statistical comparisons were carried out using the following procedure (Keil et al., 2000):

$$S_{pooled} = \sqrt{\frac{\{(N_1 - 1)/N_1 + N_2 - 2\} \times SE_i^2 + \{(N_2 - 1)/(N_1 + N_2 - 2)\} \times SE_i^2}{N_1 + N_2}},$$

$$t = \frac{(PC_1 - PC_2)/S_{pooled} \times \sqrt{1/N_1 + 1/N_2}}{1},$$

where $S_{pooled}$ is the pooled estimator for the variance; $t$ the $t$-statistic with $N_1 + N_2 - 2$ degrees of freedom; $N_i$ the sample size of dataset for information accessibility $i$; $SE_i$ the standard error of path in structural model of information accessibility $i$; $PC_i$ the path coefficient in structural model of information accessibility $i$.

Results showed that the path coefficient from community adaptivity to perceived usefulness in the high information accessibility structural model is significantly stronger than in the low information accessibility model ($t$-statistic = 4.149). Community adaptivity plays a more significant role in explaining the variance in perceived usefulness in the presence of high information accessibility.

Graphical analysis (see Fig. 4) showed that the gap difference in perceived usefulness due to information accessibility narrows across the three levels of community adaptivity. Perceived usefulness is significantly higher in high information accessibility users compared to low information accessibility users at zero
Fig. 3. Interaction effects of information accessibility and community adaptivity on perceived usefulness and perceived ease of use. (a) Results of PLS analyses for low information accessibility (N = 36). (b) Results of PLS analyses for high information accessibility (N = 36).

Fig. 4. Perceived usefulness for different levels of information accessibility and community adaptivity.
(t-statistic = 4.49, p > 0.001) and static adaptivity (t-statistic = 5.27, p > 0.001) levels, and higher (but not significantly higher) at run-time adaptivity level (t-statistic = 1.42, p = 0.171).

For practical purposes, website providers will be interested in the combined interaction and main effects. The variances explained by the two factors are rather large (about 50–65 per cent) and thus of practical importance. For comparison, Wiedenbeck and Davis (1997) found that interaction style explained only 5 per cent of perceived ease of use; Lin and Lu (2000) found that a combination of three factors explained about 50 per cent of the variance in perceived ease of use; and Venkatesh and Davis (2000) found that a combination of six factors explained about 50 per cent of the variance in perceived usefulness. With the big effects, website providers should consider these two factors seriously. They should provide run-time community adaptivity regardless of the information accessibility levels. On the other hand, higher information accessibility should lead to higher perceived usefulness only where there is lack of high community adaptivity. When website providers find it difficult to provide run-time adaptivity, they should at least provide higher information accessibility to improve perceived usefulness among users as a compensatory measure. Overall, where possible, they should try to enhance both information accessibility and community adaptivity for users.

No significant interaction effect was detected for perceived ease of use (t-statistic = 1.262). The path coefficient from community adaptivity to perceived ease of use in the high information accessibility structural model is not significantly different from that in the low information accessibility structural model.

6. Discussions and conclusions

The goal of this paper is to assess the effects of two key design issues—information accessibility and community adaptivity—on the sustainability of virtual learning communities, through an adapted Technology Acceptance Model. Our characterization of sustainability is reflected by how users felt (sense of belonging) about and perceived the community (in terms of usefulness and ease of use), and how they would consequently participate in the community. We extended TAM literature by showing empirically the significant role sense of belonging plays in a virtual learning community. We adopted an experimental design that allowed us to systematically examine the impact of information accessibility and community adaptivity. Our study exposed subjects to various virtual learning communities differentiated by the level of information accessibility and community adaptivity, and solicited their feelings toward these communities. This experimental design uses a realistic research setting (genuine course and interactions among students taking the course).

Since the study was set in a learning environment, a safe approach is to apply the findings to virtual learning communities only. This study involved a short common stage where subjects with roughly similar background were introduced to the system, and a short duration of one semester for the subjects to voluntarily use the system. While this setting may be comparable with online usage for other modules, it could
be very different from other types of virtual communities where users join at different times, and the duration could be for years. Thus, extending findings to very different virtual communities should be done with much caution. On the other hand, the factors studied (e.g. sustainability, information accessibility, community adaptivity, TAM) are generally applicable to other scenarios, such as those involving business cooperation, consumer groups or scientific groups. The activities of getting information, joining discussions, managing information and processes and so on are applicable to other virtual communities as well, e.g. in empathic virtual communities (Preece, 1998, p. 38) or in virtual political communities (Garramone et al., 1986). No doubt, there could be additional factors peculiar to certain communities. For example, another type of accessibility, terminal accessibility, was studied by Rice and Shook (1988), and privacy was studied by Preece (1998).

This study adds value by examining the process and intermediate variables through which information accessibility and community adaptivity influence intention to use. The empirical results provide very strong support for the research model. Both information accessibility and community adaptivity had significant effects on the community’s perceived usefulness and perceived ease of use from the perspective of the participants. These perceptions in turn had significant effects on the participants’ sense of belonging to the community. Perceived usefulness and sense of belonging had significant effects on participants’ intention to use the system.

These results present interesting implications. Based on our characterization of information accessibility, it appears that virtual community organizers (providers) should pay attention to information content and amount, access policies, the type of communication channels provided and information organization. Notwithstanding the obviousness of these ideas, few providers have examined these issues critically when setting up virtual communities. For instance, despite being aware of the “globalization” of their virtual communities, many providers have persistently chosen an inward-looking perspective by providing only localized information content, and neglecting international users (LedBetter, 1999). Indeed, virtual communities with a large number of international users should contemplate creating multi-lingual content (an important aspect of information accessibility) to retain its global outreach and ensure stickiness among participants.

For community adaptivity, the results show that static adaptivity is significantly different from no adaptivity. Similarly, run-time adaptivity is significantly different from static adaptivity. Among the three levels of community adaptivity, run-time adaptivity groups have the highest average intention to use. The results have some implications for adaptive structuration theory. The importance of user ability to adapt the system to their purpose is also highlighted by Soong et al. (2001), through a case study where a virtual learning community was able to overcome technical difficulties through adaptation of system features to nonintended uses.

Our characterization of community adaptivity does not rely solely on users or the institutionalization process to continuously adapt the structures and rules of interaction, as espoused by adaptive structuration theorists and empiricists (e.g. Poole and DeSanctis, 1990; Yates and Orlikowski, 1992). Instead, rules and structures of interactions are also shaped by the system itself which tracks how users
interact with the system and with others. As far as virtual learning communities are concerned, such a system-engineered reproduction of rules and structures seems to have a positive effect on user feeling, perception and behavioural intention. If these findings can be corroborated by further empirical examinations, adjustments to the adaptive structuration theory may be necessary to reflect the technological adaptive capability in the appropriation process.

The results also present a nonobvious insight. Community adaptivity, such as the personalization of the community for one’s own needs and preferences, through creating and managing favourite topics and through system-tracking of user activities, could dramatically improve the perception of usefulness and ease of use, and through them, foster a greater sense of belonging. This result shows the potent force of run-time adaptivity features, and is consistent with studies that found users have little time to perform repetitive activities or learn how to overcome frequent technology hurdles (Chervokas and Watson, 1997).

To ensure sustainability, organizers of virtual communities should find out, through regular surveys or focused-group discussions, whether their communities are useful to their users and are capable of fostering a sense of belonging. These steps are needed given the strong effects on intention to use, which is an important determinant of actual return.

An interesting route to extend this research is to assess the impact of these key variables on sustainability at a finer level in a more controlled environment. For instance, researchers can delineate access policies (public access versus private access), type of information content (expert information versus participants’ information), and mode of communication channels (text-based chats versus graphics-based chats) from the information accessibility construct and examine them in greater details. A similar approach could be applied to the community adaptivity construct. A detailed approach can make an invaluable contribution to practitioners who need to fine-tune system features to meet user expectations. In addition, since this study is among the first to adapt the scales of perceived usefulness, perceived ease of use, and sense of belonging for studying virtual learning communities, it would be prudent to refine these scales and test them further in other empirical settings. An interesting avenue for further research is to go beyond virtual learning communities and replicate this study in other types of virtual communities, such as e-commerce communities. It is our belief that replications can contribute toward a cumulative tradition in research and ensure generalizability of findings.

Appendix A. Operationalization of constructs

Perceived usefulness (1—strongly disagree; 7—strongly agree):

1. Using the virtual learning community system will improve my understanding of the course material.
2. Using the virtual learning community system will enable me to communicate and discuss with my course-mates and instructors.
3. Using the virtual learning system will help satisfy my social needs.
4. Overall, the virtual learning community system is effective in meeting my needs for the course.

   Perceived ease of use (1—strongly disagree; 7—strongly agree):
   1. The features of the virtual learning community system would be easy for me to learn.
   2. The functionalities provided in the virtual learning community system would be easy for me to use.
   3. Overall, the virtual learning community system would be easy for me to operate.

   Sense of belonging (1—strongly disagree; 7—strongly agree):
   1. I feel a strong sense of being part of this virtual learning community.
   2. I have complete trust of others in this virtual learning community.
   3. I enjoy myself as a member of this virtual learning community.
   4. I am very committed to this virtual learning community.
   5. Overall, there is a high level of morale in the virtual learning community.

   Intention to return (1—strongly disagree; 7—strongly agree):
   1. I am seriously contemplating to return to use the virtual learning community system.
   2. I believe it is worthwhile for me to return to use the virtual learning community system.
   3. Based on my experience, I am very likely to return to use the virtual learning community system.

References


