

Xie, 2003). IR system design necessitates a choice between providing system features that require little user involvement, or more interactive features that could give users more control when using IR systems. In IR processes a user is invited to be an active participant rather than a passive recipient of and reactor to output from the system (Belkin, 1993).

User involvement can be considered one aspect of user engagement, which is directly related to users' physical behavior and cognitive process to control and interact with the system to accomplish search tactics. While user engagement is a broader concept encompassing various constructs and attributes derived from overall user experience, such as aesthetic, sensory appeal, and attention (O'Brien, 2011; O'Brien & Toms, 2008, 2010), user involvement focuses more on actual behavioral and cognitive interactions that are necessary to enact search tactics. Researchers have used different terminologies to represent user involvement, such as user control and user role. For consistency, user involvement is used in the literature review. Bates (1990) is one of the early scholars who raised the issue of balancing user involvement and system support in IR system design. She explored to what extent and in what ways a user should be able to direct the system to function on their behalf. She concluded that IR systems should support the user for effective IR. System features at different levels can optimally support users' participation. Based on Bates's (1990) suggestion, several researchers began to consider both the user role and the system role in IR processes, that is, user involvement and system support in IR system design. While addressing the problems of system-dominated systems, Hendry and Harper (1997) proposed an informal information-seeking environment where a searcher increased power over the system interface during the informal problem-solving practice. Beaulieu and Jones (1998) stressed that it is imperative to determine to what extent the user and the system should play a role in IR system design. In their review of IR system design trends over time, Savage-Knepshield and Belkin (1999) pointed out that system designers progressively increased both the level of system-side support and the level of domination provided to users in designing IR systems. Xie (2003) directly compared users' perceptions of ease-of-use versus user control. The major finding of her study was that the extent of user involvement and system support differed by search activities. She also suggested desired functionalities and interface structure of IR systems in order to support both user involvement and system support. Xie further asserted that user involvement and system support are the two essential factors that lead to effective IR. Based on their experimental study, White and Ruthven (2006) investigated what types of search activities users preferred to perform. Their results show that users tended to keep more control during search result evaluation, but wanted more assistance from the system during query reformulation.

Previous research has begun to explore user involvement and system support in the search process, and concludes that it is imperative to balance both roles in the interactive IR process.

### *System Support and User Involvement for Different Types of Search Tactics*

Among different types of search tactics, user roles and system roles for query creation and modification have been widely explored in the IR research field. The interactions occur while IR systems are assisting users to articulate their information needs into specific search statements. In query creation and reformulation, the user role is to identify their information needs and convert them into a search statement. This involvement requires users to apply various levels of user knowledge to create and reformulate search queries, such as domain knowledge, system knowledge, and search skills (Hsieh-Yee, 1993; Hu, Lu, & Joo, 2013; Wildemuth, 2004; Zhang, Liu, & Cole, 2013). The system role should assist users to increase their levels of knowledge and to choose terms more relevant to their search goals. Imprecise queries or poor structure of search statements could yield inappropriate results, which consequently led users to interact with system features more often to find more relevant terms (Keselman, Browne, & Kaufman, 2008). At the same time, researchers have paid attention to the effects of advanced search features on user-system interactions. Vilar and Zumer (2008) proposed different levels of system support and user involvement by providing different types of search interfaces, basic search versus advanced search. They discussed the need for command searching to empower the levels of control for advanced users. Similarly, some features allow more control for users to handle queries. Researchers suggest adopting system features, such as those that allow for manipulating multiple queries, provide query feedback and suggestions, and enable query and search result tracking (Kelly, Gyllstrom, & Bailey, 2009; Rieh & Xie, 2006). System support is purposely designed for users to be better involved in query reformulation by providing query manipulation options, such as options for broadening or narrowing queries, suggesting related terms, or correcting misspellings (Zeng et al., 2006).

Researchers have also examined user involvement and system support in exploring tactics, which are essential for conducting browsing activities during the IR process. System support for exploration tactics helps users understand the organization of information, while user roles involve choosing relevant browsing categories or selecting items from a predefined document list. In prior studies, various system features were proposed to facilitate effective user involvement, such as toolbar options, footprints, structured breadcrumbs, and adaptive navigation (Wexelblat & Maes, 1999; Zeiliger & Esnault, 2008). Offering controlled vocabulary is another approach to support users with varying levels of domain knowledge (Mu et al., 2011). In addition, clear structure of information items is critical in effective user involvement. Herrouz, Khentout, and Djoudi (2013) argued that inadequate organization of information could lead to users being lost while exploring. When exploring information items, users make navigational choices and judgments, and systems should relieve their cognitive load