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Internet-specific epistemic beliefs and self-regulated learning in online academic information searching

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Abstract Epistemic beliefs have been considered as important components of the self-regulatory model; however, their relationships with self-regulated learning processes in the Internet context need further research. The main purpose of this study was to examine the relationships between Internet-specific epistemic belief dimensions and self-regulated learning activities while using the Internet for academic information searching. A total of 758 university students were sampled in this study. Through factor analyses, four dimensions of Internet-specific epistemic beliefs were identified, labeled as certainty of Internet-based knowledge, simplicity of Internet-based knowledge, source of Internet-based knowledge, and justification for Internet-based knowing. Factor analyses also revealed two dimensions of self-regulated learning while using the Internet for academic searching, namely preparatory self-regulated learning (i.e., task definition as well as goal setting and planning) and enactment self-regulated learning (i.e., controlling, monitoring, and reflecting). The results of the structural relationship analysis indicated that the preparatory phase of self-regulated learning positively correlated with Internet-specific epistemic beliefs relating to justification for Internet-based knowing, and was also negatively associated with two other dimensions of Internet-specific epistemic beliefs regarding simplicity of Internet-based knowledge and source of Internet-based knowledge. In addition, preparatory self-regulated learning mediated the

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relationships between these three dimensions of Internet-specific epistemic beliefs and the enactment phase of self-regulated learning.

Keywords Epistemic beliefs · Self-regulatory model · Internet-based knowledge · Information searching

Introduction

The use of the Internet by students for academic information searching has become widespread (Mason and Boldrin 2008). The Internet offers students convenient access to massive amounts of information as well as its speedy transmission. In addition, students may experience alternative ways of presenting various perspectives and concepts in Internet-based learning environments (Hartley and Bendixen 2001). Nonetheless, the Internet also presents learners with new challenges.

Since Internet-based resources are often not designed by teachers for educational purposes, students have to make more efforts to evaluate the usefulness and accuracy of information gathered from websites than in traditional instruction environments (Bråten et al. 2005; Lee and Tsai 2011). Therefore, they have to manage the learning activities by themselves. In other words, it may be essential for students to process self-regulated learning in Internet-based learning contexts. Researchers have also indicated that self-regulated learning is critical for successful online learning (Lee and Tsai 2011; Strømsø and Bråten 2010). Students who do not deploy self-regulatory processes may have difficulties in learning with Internet-based materials (Hartley and Bendixen 2001).

Dealing with a large amount of online information, students must evaluate the knowledge and justify their processes of knowing. Therefore, they have to become involved in epistemic monitoring, judgment, and self-regulation (Hofer 2004). However, it is a matter of concern that students tend to show little reflection when evaluating the materials they retrieve from websites (Bråten and Strømsø 2006; Bråten et al. 2005; Mason et al. 2011). Researchers have revealed the importance of helping students reflect on Internet-based knowledge and knowing when they access, process and interpret online information (Bråten 2008; Bråten and Strømsø 2006).

While searching for online information, students have to engage in epistemic reflections on the accessed knowledge by activating their epistemic beliefs (Mason et al. 2010b). Tsai (2004) proposed that the Internet may provide an adequate context to help learners develop evaluative standards to judge the information and knowledge acquired from Internet-based environments due to the rich information provided by Internet-based resources and the decontextualized nature of Internet-based interactions. Also, Mason et al. (2010a) indicated that students' epistemic beliefs may have an impact on their Internet-based learning in the context of online information searching.

Students adept at self-regulated learning may benefit most from computer-based learning environments such as the Internet (Greene et al. 2010). The concept of epistemic beliefs has been combined with the theoretical model of self-regulated learning (e.g., Muis 2007; Winne and Hadwin 1998). Muis (2007) proposed that epistemic beliefs are activated in the initial phase of self-regulated learning, in which early phase learners define their learning tasks and set their learning goals on their own. Researchers have examined how epistemic beliefs influence self-regulated learning; for example, Muis and Franco (2010) investigated the relationships between epistemic beliefs and metacognitive self-regulation; Strømsø and Bråten (2010) examined the relationships between epistemic beliefs about the Internet and

self-regulated learning in web-based situations; while Richter and Schmid (2010) illustrated the mechanisms by which epistemic beliefs affect self-regulated learning. All of the above provide evidence that epistemic beliefs play a role in the self-regulated learning process (Greene et al. 2010).

Although a few recent studies have proposed that epistemic beliefs may be linked to students' learning within Internet environments, Bråten (2008) suggested that there is a need to further examine the relationships between epistemic beliefs and Internet-based learning activities. Moreover, Hartley and Bendixen (2001) have suggested that it is important to investigate the relationships between epistemic beliefs and self-regulatory skills to improve learning in new instructional environments such as the Internet. Accordingly, this study mainly aimed to explore the relationships between university students' Internet-based epistemic beliefs and their self-regulated learning activities in the context of online academic information searching.

Internet-based academic information searching

Information searching on the Internet for academic purposes has become an increasingly common learning context (Mason and Boldrin 2008). Frequently, students have to search for information on the Internet to accomplish their academic tasks. College students rely heavily on Internet resources for both general and academic information searching, and the Internet has become the most basic resource for students to search for information to complete their course assignments (Metzger et al. 2003). Zhu et al. (2011) hypothesized that students' Internet information seeking may help their academic performance in mid-term examination.

To deal with diverse online information for course work, students have to evaluate the credibility of knowledge sources and justify their own knowledge in the Internet-based context. However, it has been indicated that college students perceive Internet-based information as being more credible and verify the information less than general users do (Metzger et al. 2003). Also, Mason and Boldrin (2008) found that undergraduates tend to be guided by naïve criteria for verifying online information, such as the popularity of the information source or the consistency of the knowledge claims with their own personal beliefs. Furthermore, they rely heavily on generic search engines rather than on specialized databases or elaborated search mechanisms.

Since it is a difficult task for students to judge the accuracy and relevance of information accessed on the Internet, there is a need to explore students' learning behavior in the context of Internet-based academic information searching. Thus, the issues of students' online academic information searching behaviors and strategies have been studied extensively (e.g., Biddix et al. 2011; Cheng et al. 2013; Tsai 2009; Tsai and Tsai 2003).

Epistemic beliefs

According to Schommer (1990), epistemic beliefs could be described as a system of dimensions that are relatively independent of each other, and are conceptualized as beliefs about knowledge and knowledge acquisition. Extended from Schommer's concept, Hofer and Pintrich (1997) stated that epistemic beliefs referred to beliefs composed of multiple dimensions that individuals hold about knowledge and the process of knowing. They recommended that four common dimensions be identified within the proposed construct of epistemic theories, and that they be clustered into two aspects, namely the nature of knowledge and the nature of knowing. Under the nature of knowledge aspect, there are two dimensions: certainty of knowledge and simplicity of knowledge. Certainty of knowledge measures the degree to which individual considers that knowledge is fixed or fluid. Simplicity of knowledge regards the knowledge as an accumulation of isolated facts or highly

interrelated concepts. Within the aspect of nature of knowing, there are two other dimensions: source of knowledge and justification for knowing. Source of knowledge evaluates individual's conception that knowledge comes from external authority or originates from the interaction with others. Justification for knowing refers to the approaches which individual justify knowledge claims, including the justification of experts and authority or the evaluation through multiple sources.

It has been proposed that learners' epistemic beliefs may influence their approach to knowledge construction when they are using the Internet as a tool to access information (Hartley and Bendixen 2001). Also, Mason and Boldrin (2008) indicated that epistemic judgment of online information is critical in the web-based information searching context. Furthermore, different epistemic beliefs may influence online searching and decision making differently. The empirical findings of Tu et al. (2008) suggested that students' epistemic beliefs could affect their web searching outcomes in terms of soundness and richness while completing searching tasks. Consequently, it was concluded that students' epistemic beliefs may be activated during online information searching (Mason et al. 2011). University students' epistemic beliefs are assumed to play an important role in the context of Internet-based academic information searching.

Since the Internet offers new ways of presenting knowledge and knowing, it has been suggested that measures of epistemic beliefs should focus specifically on beliefs about the nature of knowledge and knowing in Internet-based environments (Bråten 2008; Bråten et al. 2005). Based on Hofer and Pintrich's (1997) 4-dimension theoretical model of epistemic beliefs, Bråten et al. (2005) constructed the concept of Internet-based epistemic beliefs concerning Internet-based knowledge and knowing. However, their research distinguished students' Internet-specific epistemic beliefs into only two dimensions, and they were labeled as general Internet epistemic beliefs and justification for knowing. This result was different from the 4-dimension model suggested by Hofer and Pintrich (1997). This discrepancy implies that there is a need for further examination of the construct of students' Internet-specific epistemic beliefs. Therefore, in this study, factor analyses were conducted to examine the construct of Internet-specific epistemic beliefs.

Self-regulated learning

Self-regulated learning is defined in terms of metacognitive processes, that is, self-regulated learners have to plan goals, self-monitor, self-evaluate and to be knowledgeable and decisive in the processes of their learning (Zimmerman 1990). In view of the social cognitive perspective, it has been indicated that self-regulatory processes should involve three major phases: the forethought, performance, and self-reflection phases (Zimmerman 2000; Zimmerman and Schunk 2004).

Except the 3-component theoretical construct proposed by Zimmerman and his colleague, according to Winne and Hadwin's (1998) self-regulation model, self-regulated learning occurs in four sequenced phases: task definition, goal setting and planning, enactment, and adaptation. In addition, based on some common assumptions of self-regulated learning models and details of self-regulated learning activities, Pintrich (2004) proposed that the phases of goal-setting (phase 1), monitoring (phase 2), control (phase 3), reaction and reflection (phase 4) are processes embedded in many self-regulation models.

However, Pintrich (2004) claimed that not all academic learning follows these four phases since students' learning activities occur occasionally without self-regulation. Also, Winne and Hadwin (1998) claimed that their 4-phase model of self-regulated learning is a system with a weak sequence, and that the phases do not necessarily occur in order. Phase 1,

defining the task, is often skipped. Students who practice means-ends analysis frequently oscillate between phase 2 (goal setting and planning) and phase 3 (enacting study tactics). Adaptations may occur at any point (Winne and Hadwin 1998). Pintrich (2004) also indicated that many of the empirical works have found that it is not possible to separate monitoring, control, and reflecting, as these processes may occur simultaneously and dynamically while the individual progresses a task with updated goals and plans. In addition, the hierarchical or linear structure of these four phases was not strongly assumed; in other words, the earlier phases do not have to always occur before the latter phases (Azevedo 2009; Azevedo et al. 2010; Pintrich 2004).

To examine the influence of epistemic beliefs on adaptive learning, Bromme et al. (2010) tested their hypotheses separately for the preparatory planning phase of learning and the enactment phase of learning. The preparatory phase of learning corresponds to the phases of task definitions, goal setting, and planning in Winne and Hadwin's (1998) and Muis' (2007) self-regulatory models. The enactment phase corresponds to the whole self-regulated learning process according to Winne and Hadwin's (1998) model, with a focus on active enactment processes. Furthermore, Cheng et al. (2013) considered self-regulated learning as a 2-phase model labeled as basic self-regulated learning and advanced self-regulated learning. In their study, the basic self-regulated learning was regarded as the first phase of self-regulation model proposed by Pintrich (2004), indicating the extent to which students aware of their insufficient academic knowledge and set goals for learning tasks in an Internet-based environment. The advance self-regulated learning was identified with the second to fourth phases of Pintrich's (2004) model, representing the extent to which students monitor their online learning processes, adopt relevant strategies to retrieve online information, and evaluate their learning outcomes.

Since the empirical study of Pintrich et al. (2000) revealed that the 3-component construct of self-regulated learning they proposed is too complex to fit the empirical data, they suggested future studies to clarify the components and subcomponent processes of self-regulated learning. In addition, the conceptual models of self-regulated learning proposed and discussed are almost in traditional contexts rather than in the Internet-based learning environments. Therefore, there is clearly a need to explore the components and subcomponents of self-regulated learning in the Internet-based contexts.

Relationships between epistemic beliefs and self-regulated learning

Numerous researchers have hypothesized that epistemic beliefs play an important role in self-regulated learning, bringing about goals for learning and guiding self-regulatory strategies. For example, Winne (1995) indicated that students' epistemic beliefs can predict their metacognitive studying strategies in monitoring. Hofer and Pintrich (1997) posited that epistemic beliefs generate goals for learning, which may serve as a guide for self-regulatory cognition and behavior. Also, Greene et al. (2010) hypothesized that epistemic beliefs influence self-regulated learning because beliefs shape learners' perceptions of the information that they are studying and the kinds of goals that they set for learning in computer-based learning environments.

Epistemic beliefs have been combined with theoretical models of self-regulated learning (e.g., Muis 2007; Winne and Hadwin 1998). According to Winne and Hadwin's (1998) model, a learner's beliefs about knowledge and knowing might contribute to the definition of a task during the first phase of self-regulated learning (Bromme et al. 2010; Muis 2008). The basic assumption of Winne and Hadwin's (1998) model is that epistemic beliefs impact on students' internal standards, which in turn influence metacognitive monitoring and control processes (Bromme et al. 2010). According to Hofer's (2001) framework, Richter and

Schmid (2010) claimed that the impact of epistemic beliefs on self-regulated learning activities is mediated by students' learning goals.

To explain why epistemic beliefs may correlate to self-regulated learning, Muis (2007) proposed an extension model by incorporating epistemic beliefs into the self-regulated model. This model is a combination of Winne and Hadwin's (1998) and Pintrich's (2000) models of self-regulated learning. There are four phases in this integrated model including task definition (phase 1), planning and goal setting (phase 2), enactment (phase 3), and evaluation (phase 4). According to Muis' (2007) model, it is suggested that epistemic beliefs are one component of conditions that are activated in the task definition phase. In addition, Muis proposed that epistemic beliefs influence the standards learners set for learning goals during the planning phase. These standards then influence the tactics and strategies learners use to carry out tasks in the enactment phase. In turn, Muis and Franco (2009) employed this model and revealed that epistemic beliefs influence the process of self-regulated learning via the standards students set for learning, which subsequently influence the types of learning strategies they use in their education courses, as well as their achievement. The results of Muis et al. (2011) study revealed that there are relations between epistemic beliefs and metacognitive monitoring, a subordinate component of self-regulated learning.

In the Internet-based contexts, Azevedo (2005) showed that the self-regulatory model could be used as a guiding theoretical framework to examine learning with hypermedia, indicating that self-regulation is an essential factor when learning with open-ended technology-supported environments. Tsai and Chuang (2005) claimed that epistemic beliefs score was correlated with metacognitive activities such as reflective thinking while in the Internet-based learning environments. The results of their study showed that students with sophisticated epistemic beliefs are inclined to prefer the metacognitive features of Internet learning environments. Also, Lin and Tsai (2008) suggested that students who have more mature epistemic views might have more advanced standards and searching strategies for evaluating online information than students with less sophisticated views. In other words, epistemic views could foster metacognitive engagement in web-based environments. Furthermore, Strømsø and Bråten (2010) indicated that students' epistemic beliefs regarding Internet knowledge might predict their self-regulatory strategies within Internet-based learning contexts. Accordingly, this study assumed that Internet-specific epistemic beliefs may be positioned within the cognitive structure of self-regulated learning processes and be identified as having relationships with self-regulation in Internet-based information searching activities.

Divergent findings of relationships between epistemic beliefs and self-regulated learning

It has been identified that students holding sophisticated epistemic beliefs regard knowledge as tentative, subjective, and constructed (Elby and Hammer 2001). Sophisticated students believe that knowledge is complex, relative and changeable, thus evaluating knowledge from different perspectives (Pieschl et al. 2008). Despite a general consensus that sophisticated epistemic beliefs are related to deep learning approaches and better performance (Hofer and Pintrich 1997; Schommer 1990, 1993), some conflicting results about their role have been found within traditional (e.g. Hofer 1994) and Internet-based contexts (e.g. Bråten 2008; Bråten et al. 2005). Several researchers have raised the argument that holding sophisticated epistemic beliefs does not necessarily lead to better learning strategies and outcomes; sometimes possessing naïve beliefs yields a wiser strategy in specific contexts (Bråten et al. 2008; Pieschl et al. 2008).

For example, the findings of Tsai et al. (2011a) revealed that sophisticated epistemic beliefs positively associate with higher-level conceptions of learning (i.e. conceptualizing

learning as increasing knowledge, applying and attaining in-depth understanding) while learning science in a traditional context. Similarly, Hofer's (1994) empirical results showed that sophistication of epistemic beliefs is correlated with self-regulated processes of planning, monitoring and regulating cognitive activities; however, the results showed a slight divergence in different instructional contexts. The findings of this study revealed that sophisticated beliefs have a closer relationship with self-regulation in the traditional instruction context than in contexts that emphasize active and collaborative learning.

In open-ended technology environments, it has been revealed that advanced epistemic beliefs related to Internet environments could result in sophisticated web-based information searching strategies to select and organize information (Tsai et al. 2011b). Also, empirical findings have indicated that the more advanced epistemic beliefs students hold, the better metacognitive abilities they might have while searching information on the web for "open-ended" tasks (Tu et al. 2008). On the contrary, Bråten et al. (2005) found that students holding the belief that the Internet is an essential source of accurate facts (i.e., naïve beliefs in Internet-based knowledge) displayed greater intentions to search the Internet and use the information they located. Moreover, some evidence has been presented by Pieschl et al. (2008) to challenge the consensus that epistemically sophisticated students adopt deep learning rather than superficial one in a hypertext context. They found that students with sophisticated beliefs had better performance in processing learning materials via a selective learning strategy, whereas those with naïve beliefs spent more time on a single source, but adopting a deep learning approach.

Hence, Elby and Hammer (2001) questioned the general consensus regarding the sophistication of epistemic beliefs, suggesting that the generalization of epistemic sophistication should depend on context. In addition, Bråten and his colleagues raised the question concerning whether epistemic beliefs play the same role in Internet-based as in traditional learning environments (Bråten et al. 2005; Strømsø and Bråten 2010). As Hofer (1994) suggested, much work should be undertaken to research the effect of epistemic beliefs within the self-regulated learning framework in the traditional context. It was also recommended (Bråten et al. 2005; Strømsø and Bråten 2010) that there is a need to investigate the influence of Internet-based epistemic beliefs on learning activities in Internet environments.

Epistemic beliefs and self-regulated learning in Internet-specific contexts

To address the question of whether self-regulated learning is domain-general or domain-specific in nature, Alexander et al. (2011) conducted a literature review study, but concluded that the answer to this question remains equivocal. The results of their review indicated that most studies do not assess self-regulated learning in any particular academic domain. To simplify the research design, this study adopted a domain-general perspective to explore self-regulated learning. According to Boekaerts's view (1995), self-regulated learning may vary in different situations/contexts; that is, learners will self-regulate their learning in one situation, for example when processing a text, but may not self-regulate in another situation such as when writing an essay. Furthermore, researchers have indicated that self-regulation is context-specific, and that self-regulation behaviors can vary across contexts and tasks within specific contexts (Alexander 1995; Hadwin et al. 2001). For example, students' self-regulated behaviors have been found to vary across reading for learning, completing a brief essay, and studying for an examination (Hadwin et al. 2001). In the contextualist viewpoint, researchers should assess self-regulation behaviors in specific contexts (Cleary et al. 2012).

It has been proposed that epistemic beliefs are both domain-general and domain-specific (Muis et al. 2006). That is, individuals may have general beliefs about knowledge as well as academic knowledge (Buehl and Alexander 2001). The study of Buehl et al. (2002) provided

some evidence of domain-generality in undergraduates' epistemic beliefs. However, scholars have also emphasized the context-sensitiveness of epistemic beliefs. For example, Mason and her colleagues raised the issue of considering beliefs about knowledge and knowing in a specific context of online information searching and learning (Mason et al. 2010a, 2011). As the Internet may become one of the major sources of knowledge and knowing for students (Mason and Boldrin 2008), an investigation of students' epistemic beliefs specifically in the context of the Internet may be necessary at this stage.

Although some previous studies have tested the role of epistemic beliefs in online learning activities, the epistemic beliefs under investigation were general and in traditional rather than Internet-specific contexts (e.g., Hartley and Bendixen 2001; Mason and Boldrin 2008; Pieschl et al. 2008). Due to the growing emphasis on the context-specific situation of self-regulated learning and epistemic beliefs, the focus of this study was on evaluating these two constructs in an Internet-specific context.

Measuring epistemic beliefs and self-regulated learning

Various approaches for measuring epistemic beliefs and self-regulated learning have been proposed and discussed, such as the measurements of self-regulated learning (including self-report questionnaires, structure interviews, think aloud measures, and so on) illustrated by Winne and Perry (2000), and a modern way of measuring self-regulation in computer-based learning environments (CBLEs) specified in the special issue of Educational Psychologist (e.g., Azevedo et al. 2010; Greene and Azevedo 2010; Winne 2010), as well as instrumental and think-aloud methodologies for measuring personal epistemic beliefs (Hofer 2000, 2004). It has been concluded that there is no one perfect measure of metacognition (Pintrich et al. 2000), because the advantage of one method is often the disadvantage of another.

Since the quality of data from self-report measures is an issue of concern, self-report methods for assessing epistemic beliefs and self-regulation have been widely criticized (e.g., Greene and Azevedo 2010; Hofer 2004; Winne 2010). As Greene et al. (2010) mentioned, self-report measurements offer trimmed instruments to present limited processes of learning activities, which cannot capture the complete picture of self-regulated learning. Hofer and Sinatra (2010) also indicated that the reliability and validity of the measures and the response bias are the problems in measuring epistemic beliefs with self-report measures, which may challenge the validity of representing learners' awareness of their views about knowledge. Despite these criticisms, however, it has not been suggested that such measures should be abandoned (Greene et al. 2010), as they are also considered as being both efficient and inexpensive (Paulhus and Vazire 2007). Muis and Franco (2010) also recommended that it is worthy to use self-report measures to estimate learners' tendency of their learning activities. For example, Hofer (2000) examined the dimensionality of epistemic beliefs and Muis (2008) explored self-regulated learning by adopting such self-report approach.

To clarify the dimensions of epistemic beliefs and components of self-regulated learning in the Internet-based environment and to test the relationships between these two constructs, factor analyses and structural equation modeling of questionnaire data were conducted in this study. A self-report questionnaire survey was chosen to explore these two constructs.

Research purposes

The main purpose of this study was to examine the relationships among students' Internet-specific epistemic beliefs and self-regulated learning activities while using the Internet for academic information searching to accomplish course-related tasks. As Strømsø and Bråten

(2010) indicated, epistemic belief measures should be modified to adapt to Internet-based situations since the Internet allows for new ways of presenting knowledge and knowing. Therefore, Bråten et al.'s (2005) Internet-Specific Epistemic Questionnaire (ISEQ) was employed to measure students' beliefs about knowledge and knowing regarding course-related information on the Internet. Additionally, to assess students' self-regulated learning activities while using the Internet to search for academic information, Cheng et al.'s (2013) framework of self-regulated learning was employed since it was developed and conducted in similar conditions. Based on Muis' (2007) integrated self-regulatory model, this study assumed that students' Internet-specific epistemic beliefs were predictors, and self-regulated learning activities were outcome variables. Further, structural equation modeling analysis was conducted to examine the relationships among these variables.

Method

Procedure

The procedure of data collection involved three phases: collecting data for exploratory factor analyses, recruiting the second group of participants for confirmatory factor analyses, and employing the third group to examine the hypotheses. Twelve teachers from six universities were requested to administer this survey. Data collection took place at the end of their classes. All students recruited from these classes had experience of searching for academic information to accomplish their course tasks on the Internet. At the beginning of the survey, the students were told to respond to the questionnaire by recalling their experience of searching for academic information on the Internet for their course tasks. The participants answered the survey voluntarily and were assured that their personal information would be kept confidential.

Participants

Three groups of university students, 758 in total, were recruited in this study. A pilot group with 150 respondents was sampled to conduct the exploratory factor analysis, another group with 240 extra students was for confirmatory factor analysis, and the third, with 368 formal respondents, was used to test the hypothesized model.

As mentioned, the participants consisted of 758 university students in Taiwan, of which 364 were males and 394 females, with an overall mean age of 21.13 (SD=1.49). They were from diverse fields including the humanities (law, Chinese, and English), sciences (physics and chemistry), social sciences (sociology and finance), engineering (electrical engineering and mechanical engineering), medicine (medicine, nursing, and pharmacy), and education (education and science education). Most of them (24.1 %) revealed that their Internet usage time ranged from 21 to 30 h per week, and 20.8 % reported usage time ranging from 11 to 20 h per week. In all, 62.4 % used the Internet in excess of 20 h per week. In addition, most (86.3 %) of the respondents indicated that they accessed academic information via the Internet at least once a week.

Measures

Two questionnaires measured with a Likert scale from 1 "do not agree at all" to 7 "strongly agree" were employed to investigate the university students' Internet-specific epistemic

beliefs and self-regulated learning while accessing online academic information. To test the construct validity of these two questionnaires, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were both conducted for these two questionnaires. A description of the questionnaires' contents and the results of the factor analyses are presented below.

The Internet-Specific Epistemic Questionnaire (ISEQ), translated into Chinese for this study, was adopted to investigate the respondents' Internet-specific epistemic beliefs. The ISEQ was developed by Bråten et al. (2005) based on Hofer and Pintrich's (1997) 4-dimension model of epistemic beliefs. The initial ISEQ was a 36-item questionnaire designed to assess two dimensions concerning the nature of Internet-based knowledge, labeled as certainty of Internet-based knowledge and simplicity of Internet-based knowledge, as well as the other two dimensions concerning the nature of Internet-based knowing, labeled as source of knowledge and justification for knowing. However, the results of the factor analysis in their study revealed that the ISEQ is an 18-item questionnaire divided into two factors, one 14-item factor labeled general Internet epistemic beliefs, and one 4-item factor labeled justification for knowing.

To clarify the dimensions of the ISEQ, an EFA with a pilot sample of 150 was carried out in this study. Based on the scree plot and the theoretical model, four factors were suggested to be extracted. Finally, twelve items with factor loadings higher than 0.5 were included in the final analysis. The total variation explained by these 12 items reached 77.97 %. Each of the four factors includes three items loaded to the anticipated dimensions. To comply with Hofer and Pintrich (1997) as well as Bråten et al. (2005), these four dimensions are labeled as certainty of Internet-based knowledge, simplicity of Internet-based knowledge, source of Internet-based knowledge, and justification for Internet-based knowing. Except for the items of the justification factor, the items of the other three factors were all reversed while calculating the scores. This denotes that higher scores present more sophisticated epistemic beliefs. For example, higher scores for simplicity indicate stronger disagreement with simple Internet-based knowledge. See Appendix A for the factor loadings of EFA and Cronbach's alphas.

The certainty of Internet-based knowledge dimension measured the belief considering Internet-based knowledge as tentative and changeable rather than fixed and certain truths. Students who had high scores on this dimension indicated that they were more likely to doubt the claim that the course-related knowledge found on the Internet is truth with certainty.

The simplicity of Internet-based knowledge dimension assessed the belief regarding the knowledge located on the Internet as interrelated concepts and complex knowledge rather than simple and an accumulation of specific facts. High scores represented the view that the Internet does not contain simple and detailed knowledge related to students' study.

The source of Internet-based knowledge dimension evaluated the belief that the Internet is a good source of knowledge. High scores on this dimension indicated that the students are inclined to suspect that the Internet is a good source containing the most essential and correct knowledge related to their study.

The justification for Internet-based knowing dimension concerned the evaluation of knowledge claims on the Internet by checking multiple sources. High scores on this dimension represented students' agreement with belief that Internet-based knowledge claims should be critically evaluated against other sources.

By revising the self-regulated learning scale from Cheng et al. (2013), this study developed a questionnaire to explore university students' perceptions of self-regulated learning activities while accessing online academic information. There were 10 items included in the self-regulated learning scale of Cheng et al. (2013). These items consist of the planning, monitoring, controlling and reflecting phases, designed mainly based on the

theoretical framework suggested by Pintrich (2004). An EFA with a pilot sample of 150 was conducted to clarify the components of self-regulation model in the Internet-based learning environments. According to the scree plot and theoretical framework, two factors were extracted in the analysis. Since items with small loadings less than 0.5 were eliminated, six items with factor loadings ranging from 0.65 to 0.89 were included in the final analysis. The six items of these two factors explained 73.76 % of the total sample variation.

According to the view of Pintrich et al. (2000), monitoring, control, and reflection may occur simultaneously. In addition, Winne and Hadwin (1998) indicated that students frequently oscillate between phase 2 (goal setting and planning) and phase 3 (enacting study tactics). As a result, in this study it seemed reasonable to group monitoring, control and reflection into a single factor. Consequently, referring to the typology clustered by Bromme et al. (2010), these two factors are named as preparatory self-regulated learning (SRL), including task definition, planning and goal setting, and enactment SRL, including control, monitoring and reflecting.

Preparatory SRL included 3 items, representing the extent to which students may set learning goals, learning subjects and learning strategies for relevant learning tasks in an online environment. Enactment SRL included 3 other items, measuring the extent to which students may monitor, evaluate and improve their learning process while performing their academic tasks online. Students recalled their actual SRL experience to respond to these statements. Higher scores for these two dimensions indicate higher intent regarding preparatory SRL and enactment SRL, respectively. See Appendix B for factor loadings and Cronbach's alphas.

Generally, the constructs of these two instruments fit the models that have been conceptualized in the literature. There were cross-loadings among a few of the items. According to the definition of Hair et al. (2006), when a variable is found to have more than one significant loading, it is termed a phenomenon of cross-loading. In a sample of 150, a factor loading of 0.45 may be considered as having significance (Hair et al. 2006). As Appendix A and Appendix B demonstrate, one item of ISEQ and two items of SRL that load greater than 0.45 on more than one factor should be noted.

Furthermore, a CFA with 240 participants from another data set was performed to examine how well the data fit the suggested models. A single CFA with all items and factors of ISEQ and SRL recruited in one model was executed to clarify the reliability and validity of both instruments. The constructs of ISEQ and SRL included in the tested model were presented in Fig. 1. As shown in Appendix C, values of univariate skewness and kurtosis range from −0.68 to 1.02. Using the absolute value of 2 as a criterion, all items are over −2 and less than 2, and no item is considered to have a severe normality problem (Bandalos and Finney 2010). The factor loadings, average variance extracted (AVE), and composite reliability (CR) are also calculated to assess the convergent validity of the constructs (Hair et al. 2006). As shown in Appendix C, all items have significant factor loadings which are higher than 0.5 and smaller than 0.95 (Bagozzi and Yi 1988; Bollen 1989; Raines-Eudy 2000). Compared with the cutoff value of 0.6, the CR values ranging from 0.78 to 0.86 indicate acceptable reliability of the constructs (Bagozzi and Yi 1988). In addition, the AVE values ranging from 0.54 to 0.67 are higher than 0.5, indicating adequate convergent validity of the constructs (Hair et al. 2006). With respect to the model fit indices (χ^2=162.04, df=120, p=0.06, χ^2/df=1.35, goodness of fit index (GFI)=0.93, adjusted goodness of fit index (AGFI)=0.90, normal fit index (NFI)=0.93, standardized root mean square residual (SRMR)=0.046, and root-mean-square error of approximation (RMSEA)=0.028), these results suggest a good data-model fit (Hair et al. 2006).

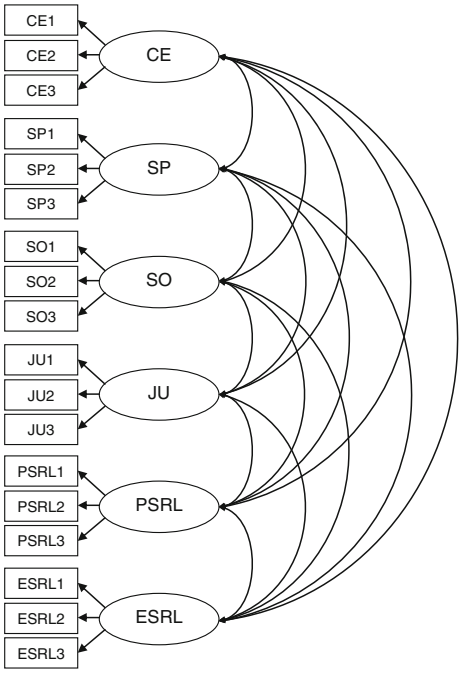

Fig. 1 The constructs of Internet-specific epistemic beliefs and self-regulated learning included in one single model for confirmatory factor analysis. Note: *CE* certainty of Internet-based knowledge, *SP* Simplicity of Internet-based knowledge, *SO* source of Internet-based knowledge, *JU* justification for Internet-based knowing, *PSRL* preparatory SRL, *ESRL* enactment SRL

Hypothesized model

Based on Muis' (2007) integrated model, epistemic beliefs may be combined with self-regulated learning processes. Additionally, according to the aforementioned literature (e.g., Greene et al. 2010; Hofer and Pintrich 1997; Winne 1995), it is posited here that Internet-specific epistemic beliefs might associate with preparatory SRL and enactment SRL, as researchers (e.g., Bromme et al. 2010; Hofer and Pintrich 1997; Muis 2007) have indicated that epistemic beliefs may be activated in the preparatory phase (i.e., the task definition phase) and determine standards which in turn lead to self-regulatory activities in the enactment phase. Therefore, it was assumed in this study that preparatory SRL could mediate the relationships between Internet-specific epistemic beliefs and enactment SRL. The hypothesized model is presented in Fig. 2. The relationships among Internet-specific epistemic beliefs, preparatory SRL and enactment SRL, as well as the relationships between preparatory SRL and enactment SRL, were examined. However, because divergent relationships among these variables were found in prior studies, the expected outcomes were not specifically indicated.

Results

The descriptive statistics and correlation coefficients of the research variables in this study are presented in Table 1, according to which the justification dimension is negatively correlated with simplicity of Internet-based knowledge (r=−0.21). However, the other three dimensions of source, simplicity and certainty of Internet-based knowledge are positively correlated with each other (0.54, 0.65 and 0.55, respectively). Other than the justification

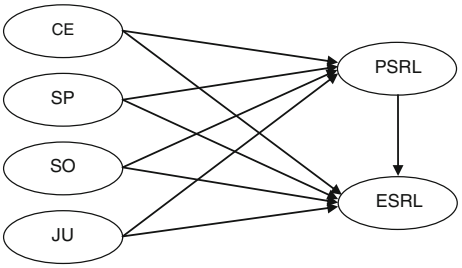

Fig. 2 The hypothesized model of relationships between Internet-specific epistemic beliefs and self-regulated learning. Note: *CE* certainty of Internet-based knowledge, *SP* Simplicity of Internet-based knowledge, *SO* source of Internet-based knowledge, *JU* justification for Internet-based knowing, *PSRL* preparatory SRL, *ESRL* enactment SRL

dimension having a positive correlation with preparatory SRL (r=0.35) and enactment SRL (r=0.25), the other three dimensions are negatively correlated with both dimensions of SRL (with the coefficients ranging from −0.16 to −0.31). Besides, preparatory SRL and enactment SRL are positively correlated with each other (r=0.62).

The path analysis with observed variables was conducted using structural equation modeling (SEM) to examine the path relations between the Internet-specific epistemic beliefs and self-regulated learning. The SEM was executed with 368 participants from the third group of the sample. The path coefficients of the hypothesized model are presented in Table 2. Simplicity of Internet-based knowledge, source of Internet-based knowledge and justification for Internet-based knowing have significant correlations with preparatory SRL. However, none of these four dimensions of Internet-based epistemic beliefs has a significant relationship with enactment SRL. Similar to the results of previous correlation analysis, the results of path analysis show that preparatory SRL is significantly positively related to enactment SRL.

For graphical illustration, the structural model is simplified as Fig. 3. Compared with Fig. 2, the initial hypothesized paths with non-significant coefficients are not presented. Because none of the four dimensions of Internet-specific epistemic beliefs has a significant relationship with enactment SRL, the earlier hypothesized paths between the dimensions of Internet-specific epistemic beliefs and enactment SRL are not displayed in Fig. 3. Also, the certainty of Internet-based knowledge is not included since this dimension does not have a significant relationship with either preparatory SRL or enactment SRL.

Table 1 Means, standard deviations and correlations of variables

Variables	Means	SD[a]	1	2	3	4	5
1. Certainty	3.67	1.07					
2. Simplicity	3.32	1.03	0.55***				
3. Source	3.71	1.23	0.65***	0.54***			
4. Justification	5.70	0.81	−0.08	−0.21***	−0.05		
5. Preparatory SRL	5.24	0.92	−0.16**	−0.28***	−0.24***	0.35***	
6. Enactment SRL	4.85	0.98	−0.19***	−0.31***	−0.23***	0.25***	0.62***

[a] standard deviation

** p<0.01

*** p<0.001

Table 2 Path coefficients of structural equation modeling (Path coefficients are standardized coefficients)

Predict variables	Preparatory SRL	Enactment SRL
Certainty	0.16	−0.05
Simplicity	−0.20*	−0.12
Source	−0.25*	0.08
Justification	0.35***	−0.03
Preparatory SRL	–	0.75***

*$p<0.05$ ***$p<0.001$

The structural equation model resulted in appropriate model fit indices ($\chi^2=164.49$, $df=120$, $p=0.082$, $\chi^2/df=1.37$, goodness of fit index (GFI)=0.95, adjusted goodness of fit index (AGFI)=0.93, comparative fit index (CFI)=0.99, normal fit index (NFI)=0.95, and root-mean-square error of approximation (RMSEA)=0.032).

As shown in Fig. 3, simplicity of Internet-based knowledge has a negative relation (−0.2) to preparatory SRL; in addition, source of Internet-based knowledge negatively (−0.25) predicts preparatory SRL. However, justification for Internet-based knowing positively (0.35) associates with preparatory SRL. Furthermore, preparatory SRL positively correlates to enactment SRL with a significant path coefficient of 0.75.

According to the recommendation of MacKinnon and his colleagues (MacKinnon et al. 2002; MacKinnon et al. 2007), the Sobel's Z was calculated to test the mediating relationships of preparatory SRL between Internet-based epistemic beliefs and enactment SRL. As shown in Table 3, the significant Sobel Z ($|Z|>1.96$, $p<0.05$), ranging from −2.97 to 4.56, denotes that preparatory SRL plays a significant mediating role, through which Internet-based epistemic beliefs (i.e., simplicity, source and justification) may be indirectly linked to enactment SRL.

Discussion

This study advances the theory of epistemic beliefs and self-regulated learning by testing dimensions of the theoretical framework of Internet-specific epistemic beliefs and self-regulated learning in Internet-based situations. In addition, by using Winne and Hadwin's (1998) and Muis' (2007) self-regulatory model, this study responds to Hartley and Bendixen's (2001) calls for studies linking epistemic beliefs with self-regulated learning in Internet-based environments. Specifically, this study conducted structural equation modeling to test the relationships between Internet-specific epistemic beliefs

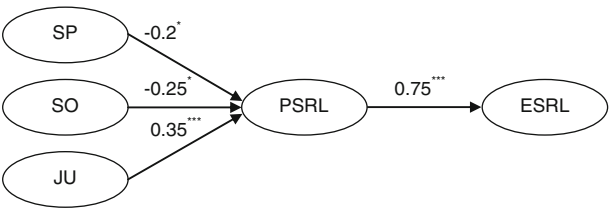

Fig. 3 The simplified structural equation model. Note: The path coefficients are standardized coefficients. *SP* Simplicity of Internet-based knowledge, *SO* source of Internet-based knowledge, *JU* justification for Internet-based knowing, *PSRL* preparatory SRL, *ESRL* enactment SRL. * $p<0.05$ *** $p<0.001$

Table 3 Mediation relationship of preparatory SRL between epistemic beliefs and enactment SRL

	Coefficients	SE	S_{ab}	Sobel Z
SP				
Path a (SP→PSRL)	−0.201	0.059	0.051	−2.971
Path b (PSRL→ESRL)	0.753	0.119		
SO				
Path a (SO→PSRL)	−0.252	0.084	0.071	−2.684
Path b (PSRL→ESRL)	0.753	0.119		
JU				
Path a (JU→PSRL)	0.353	0.053	0.058	4.561
Path b (PSRL→ESRL)	0.753	0.119		

CE certainty of Internet-based knowledge, *SP* Simplicity of Internet-based knowledge, *SO*source of Internet-based knowledge, *JU* justification for Internet-based knowing, *PSRL* preparatory SRL, *ESRL* enactment SRL
$S_{ab} = \text{SQRT}\ (a^2 \times SE_b^2 + b^2 \times SE_a^2 + SE_a^2 \times SE_b^2)$; Sobel $Z=(a\times b)/S_{ab}$

and self-regulated learning. This is a response to Muis' (2007) suggestion that more studies are needed which use advanced statistical techniques such as structural equation modeling. Such techniques allow for more directional tests of relationships between variables.

Dimensionality of ISEQ and the SRL scale

In this study, EFA and CFA were conducted to explore and clarify the constructs of the theoretical models of epistemic beliefs and self-regulated learning in Internet-specific contexts. Although the results of these factor analyses cannot provide definitive answers to establish well-constructed theoretical models, the results may provide evidence to support the alternative models and perspectives of these two constructs in the Internet-based learning environments.

First, the analysis results showed that a 12-item ISEQ with four factors has an appropriate model fit, indicating that the four factors of Internet-specific epistemic beliefs may fit the proposed model developed from a review of the literature. This result is in accordance with Hofer and Pintrich's (1997) model of epistemic beliefs, suggesting that the Internet-based epistemic beliefs model should be identified within the proposed construct of epistemic beliefs, and be divided into four dimensions: certainty of Internet-based knowledge, simplicity of Internet-based knowledge, source of Internet-based knowledge and justification for Internet-based knowing.

Moreover, the EFA and CFA results of self-regulated learning indicated that students' self-reports of their self-regulated learning processes may fit the 2-phase model proposed in this study. However, because a small number of items were used to assess the concepts of SRL in this study, these two components of Internet-based SRL measured may be some subcomponents of self-regulated learning in Internet-specific contexts, which may not fully capture the whole processes of self-regulation model. In accordance with the findings of Cheng et al. (2013), this result suggests that these two components of students' self-regulated learning activities in an Internet-based academic information searching context may constitute a 2-phase model, labeled as the preparatory SRL phase (i.e., task definition, goal setting and planning) and the enactment SRL phase (consisting of monitoring, controlling and reflecting) based on

the typology of Bromme et al. (2010). This finding is somewhat parallel to Pintrich et al.'s (2000) and Pintrich's (2004) ideas, indicating that monitoring, control, and reflection may occur simultaneously; therefore it is not possible to separate monitoring, control and reflection from each other in the self-regulated learning process.

Relationships between Internet-specific epistemic beliefs and self-regulated learning

To explore the integrated model of epistemic beliefs and self-regulated learning proposed by Muis (2007), SEM analysis was used to examine the structural relationships within these processes. The SEM results revealed that three dimensions of Internet-based epistemic beliefs, namely simplicity, source and justification, were correlated with preparatory SRL rather than with enactment SRL in the Internet-based academic information searching context. Consistently, this finding responds to Winne and Hadwin's (1998) as well as Muis' (2007) self-regulatory models both of which proposed that epistemic beliefs may be activated during the preparatory phase of the self-regulated learning process. Further, based on this definition, students generate goals and make plans for this task in the preparatory phase of the self-regulatory process. Also, this finding is in accordance with the claims of Bromme et al. (2010), indicating that learners' epistemic beliefs are more influential during the preparatory stage (i.e., task definition, goal setting and planning) than during the enactment phase.

In this study it was found that justification for Internet-based knowing positively relates to self-regulated learning in Internet-based information searching contexts. The more sophisticated beliefs about justification for Internet-based knowing that students have, the greater tendency they have to adopt preparatory phase activities in the self-regulated learning process. This indicates that students who possess the tendency to justify the information on websites may like to set their own goals and strategies while studying in Internet environments. This finding responds to the consensus that students with highly sophisticated epistemic beliefs are likely to adopt better learning approaches (Hofer and Pintrich 1997; Schommer 1990). Similarly, the result found by Strømsø and Bråten (2010) indicated that students who tend to check Internet-based knowledge against other resources are quite likely to use self-regulatory strategies.

On the other hand, it was found that students with sophisticated beliefs about simplicity who question the wealth of details and facts of Internet-based knowledge may be less likely to undertake the preparatory phase SRL (i.e., task definition, goal setting and planning) while searching for academic information in Internet contexts. Again, this is consistent with Strømsø and Bråten's (2010) result indicating that students who query whether Internet-based knowledge is detailed and concrete are less likely to engage in self-regulatory strategies when learning with Internet technologies. Probably, these results may be explained by the view that students holding naïve beliefs about Internet-based knowledge (i.e., reflecting the idea that the Internet is an essential source of detailed knowledge) are inclined to deal with the Internet-based sources and use relevant information (Bråten et al. 2005). However, this finding does not imply that students with sophisticated Internet-specific epistemic beliefs do not have the capability to engage in self-regulated learning. This may be interpreted such that students with sophisticated beliefs about simplicity possess less willingness to undertake self-regulated learning on the Internet since they suspect the wealth of details and facts of Internet-based knowledge.

In addition, students holding sophisticated beliefs about the source of Internet-based knowledge, and who doubt that the Internet is a good source of course-related knowledge, are less likely to perform the basic activities of self-regulated learning on the Internet. Similarly, Kammerer and Gerjets (2012) showed that when searching for information on the Internet, those students who agree that the Internet contains correct knowledge performed more information selection and had better search outcomes than those who do not share the same opinion. In other words, because of having a high level of trust in the source of Internet-based knowledge, these students tended to perform preparatory SRL activities. On the contrary, due to their suspicion of the information sources on the Internet, students might have less chance to use these sources and related activities of preparatory SRL during their study.

Furthermore, the SEM results and the mediation test showed that preparatory SRL mediated the relationships between epistemic beliefs and enactment SRL, indicating that Internet-based epistemic beliefs may have indirect relationships with the enactment phase of the self-regulated learning process through the preparatory phase. These results provide evidence consistent with Hofer and Pintrich's (1997), Muis' (2007) as well as Muis and Franco's (2009) views, indicating that epistemic beliefs may be associated with self-regulated learning by providing goals that guide the learning process. Hofer and Pintrich (1997) indicated that epistemic theories function as a goal to initiate, assess and control their self-regulatory processes. According to Muis' (2007) integrated model of self-regulated learning, epistemic beliefs may be activated in the phases of task definition and planning and goal setting (i.e., the preparatory SRL), then the goals of the planning phase will in turn be connected to the enactment and evaluation phases (i.e., the enactment SRL). Based on Winne and Hadwin's (1998) self-regulatory model, self-regulated learning occurs in weakly sequenced and recursive stages. Moreover, Pintrich (2000) indicated that goal setting can actually occur at any point during performance, but is often assumed to occur before starting a task. Also, this finding is in line with Richter and Schmid's (2010) mediation model, indicating that learning goals are mediator variables between epistemic attitudes and self-regulated learning activities. This study provides evidence in support of the mediating role of preparatory SRL between Internet-specific epistemic beliefs and enactment SRL.

Contradictory findings about "sophisticated" epistemic beliefs

It was found in this study that students with certain sophisticated epistemic beliefs did not possess tendencies to undertake self-regulated learning in Internet-based environments. Similarly, Bråten et al. (2005) have raised the issue of whether sophisticated epistemic beliefs have the same function within Internet-based environments as in more traditional environments. In addition, there are some controversies about the effects of so-called "sophisticated epistemic beliefs" on learning activities, with numerous researchers having made different comments or having come to different conclusions on this issue (Elby and Hammer 2001; Hartley and Bendixen 2001; Hofer 1994; Pieschl et al. 2008). Specifically, this study examined the relationships of Internet-based epistemic beliefs with self-regulated learning, and the findings indicated that the students with sophistication of Internet-based knowledge and knowing do not necessarily have higher tendency to adopt self-regulated leaning within Internet-based contexts.

Thus, the question "do sophisticated epistemic beliefs benefit learning?" needs further consideration. For example, Deng et al. (2011) proposed a refinement for judging the "sophistication" of epistemic beliefs in science education, since it is not necessarily true that students holding more sophisticated views attain better performance. Accordingly, the outcomes of "sophisticated epistemic beliefs" continue to be contradictory and need to be further researched, especially in the new learning context of technology tools such as the Internet.

Future research and implications

Numerous researchers have attempted to explain the inconsistent correlations between epistemic beliefs and learning activities. Pieschl et al. (2008) have postulated that sophistication entails flexibility or adaptability to contextual demands. The nature of epistemic beliefs is context-sensitive, as they can be activated in one context but not in another (Mason et al. 2010a; Strømsø and Bråten 2010). Different epistemic beliefs may be activated by the same student for different situational variables of the learning context and instructional practice, such as task types, assessment practices, learning purposes, learning materials, and so on (Mason et al. 2011). For example, the findings of Tu et al. (2008) showed that epistemic beliefs have diverse influences on different types of searching tasks. Only in "open-ended" task contexts where searching questions were less certain did students who had more advanced epistemic beliefs possess better searching strategies.

From the perspective of sophistication, it is agreed that knowledge is interconnected rather than disconnected. Nevertheless, Elby and Hammer (2001) pointed out that sophistication does not consist of a blanket belief in either simplicity or complexity. They give an example that learning physics knowledge differs from learning the names of state capitals, since the former has to deal with more complexity and requires deeper learning rather than quick learning. On the contrary, students may adopt memorization while learning a simple issue such as the names of state capitals, even though they may hold sophisticated epistemic beliefs. Which learning strategies or activities students choose depends on the study issues rather than on the students' epistemic beliefs. In other words, the variation of study issues may change the relationship between epistemic beliefs and learning activities.

Also, inferring from Winne and Hadwin's (1998) model, Pieschl et al. (2008) indicated that epistemic beliefs should have a stronger influence on learning complex material than on learning simple material; therefore, they predicted not only main effects but also interaction effects with external conditions for epistemic beliefs. Specifically speaking, the external task demands or domains should be considered with potential interaction effects between epistemic beliefs and learning activities. For example, if a student has sophisticated epistemic beliefs and his/her goal is to pass examinations, he/she is likely to accept answers from an authority such as a teacher, or to adopt a rote learning strategy rather than a deep one, even if he/she has sophisticated beliefs.

Therefore, it is suggested that further work is required explore the external conditional factors (e.g., study issues, task demands and learning materials) that may moderate the relationships between students' Internet-based epistemic beliefs and self-regulatory learning in Internet-based information searching contexts.

Numerous studies (e.g., Hofer 1994; Muis and Franco 2009) have conducted research to explore the relations between epistemic beliefs and self-regulated learning. However,

few studies have explored these variables within Internet environments, in particular, focusing on Internet-specific epistemic beliefs (e.g., Bråten et al. 2005; Strømsø and Bråten 2010). The results of this study may contribute to a better understanding of Internet-specific epistemic beliefs and self-regulated learning in Internet environments. However, the relationship of Internet-based epistemic beliefs to learning performance mediated by self-regulation was not explored in this study. According to the results, it is suggested that beliefs regarding Internet-based knowledge and knowing may or may not have relationships with students' willingness to take self-regulatory action in Internet environments, but it could not be supposed that this will correlate to either unfavorable or better learning performance. Pieschl et al. (2008) have indicated that epistemic beliefs are associated with calibrated learning strategies, and epistemic beliefs would indirectly impact learning outcomes. In other words, students' beliefs regarding Internet-based knowledge and knowing may not imply their capability or learning outcomes, but rather their choices of learning activities on the Internet. As Hofer and Pintrich (1997) concluded, further work is needed to better understand how epistemic beliefs may enhance academic performance via the learning strategies and activities chosen. It is proposed that future research examine the correlations between Internet-specific epistemic beliefs and learning outcomes through self-regulatory activities in Internet-based learning contexts.

As Hofer and Pintrich (1997) suggested, epistemic beliefs may act as a standard or goal to start self-regulatory processes. The findings of this study also indicate that those students who considered that Internet-based knowledge should be checked were more likely to initiate the preparatory phase of self-regulation in the Internet-based academic information searching context. The findings of this study highlight the important position of justification for Internet-based knowing within the self-regulatory model in Internet-based learning contexts.

Moreover, Tsai and Chuang (2005) concluded that metacognitive activities play an essential role in Internet-based learning environments; therefore, there is a need for educators to improve students' epistemic beliefs to facilitate the utilization of metacognitive activities in Internet-based environments. In addition, it was concluded that there is a need to better understand the instructional environments that support students to develop more sophisticated reasoning and beliefs about knowledge (Hofer 1994; Schommer 1990). Accordingly, it is suggested that further research should be carried out on the instructional methods for developing students' skills in identifying Internet-based knowledge to facilitate their access to and use of Internet-based knowledge by improving their ability to justify the wealth of information with multiple resources, and identify the appropriate knowledge located on the Internet. Hopefully, this may be helpful in encouraging students to adopt self-regulated learning while searching for academic information on the Internet on their own.

Limitations

Two major limitations of this study need to be mentioned. The first concern is the self-reported measures of students' self-regulated learning processes and epistemic beliefs. For instance, self-reported measures treat self-regulated learning as an aptitude whereby respondents reply questions by generalizing their actions across general situations rather than referencing specific learning events (Winne and Perry 2000). Inherent in the self-regulated learning models is the assumption that learners adept at self-regulatory skills may alter their learning process within and between tasks in

response to various situational factors. Therefore, it is difficult to use self-reported measures to produce valid data from the dynamic processes of self-regulated learning (Greene and Azevedo 2010). Winne and Perry (2000) proposed that self-regulated learning can be conceptualized in terms of events. Events are various actions learners perform, rather than mental states of actions (Winne 2010). Alternative methodologies such as concurrent think-aloud and online tracing (e.g., eye tracking) have been recommended to reveal the varying characteristics of self-regulated learning. Similarly, the use of self-reported questionnaires to measure epistemic beliefs has received some criticism in the field (e.g., Mason et al. 2010b; Muis et al. 2011; Richter and Schmid 2010). It is suggested that more dynamic assessments of epistemic beliefs be implemented to provide in-depth views of epistemic thinking processes in Internet-based environments (Bråten and Strømsø 2005; Strømsø and Bråten 2010). For example, the think-aloud methodology allows the capturing of epistemic beliefs in a specific context characterized by the task of searching for web-based information (Mason et al. 2011). As Pintrich (2002) argued, there is a need to execute other designs beyond one-time-point correlational designs and the use of self-reported measures in order to thoroughly specify the relationships between epistemic beliefs and other constructs. It is likely that the use of other methodologies rather than self-reported measures may clarify the findings of this study.

The second concern is that various domain-specific tasks which students encounter may alter their beliefs about Internet-based knowledge and knowing while searching for information to complete their course tasks. For example, students may believe that the Internet offers correct information for simple questions with specific answers rather than for complex questions with ambiguous answers. Since the participants in this study were asked to respond to the ISEQ for general situations and not for specific tasks, their perceptions of Internet-based epistemic beliefs may vary when they carry out domain-specific tasks on the Internet. That is to say, the relationships among Internet-specific epistemic beliefs and self-regulated learning may also differ in various contexts. Therefore, future research should explore related issues focusing on domain-specific contexts.

Conclusions

The Internet provides various and massive resources for students to easily search course-related information to complete their school assignments. Even though the Internet may construct an efficient learning environment, the trustworthiness of the Internet-based information should be concerned. As commended by Mason and Boldrin (2008), to be a sophisticated user of information the individual should be epistemically active while searching information in the Internet-based learning contexts.

In conclusion, the findings of this study indicated that students' Internet-specific epistemic beliefs are essential components for processing their learning activities of self-regulation while searching course-related information in the Internet-based environments. Metacognitive learning skills may be especially important for students to conduct their works on the Internet. Teachers are expected to be aware of students' Internet-specific epistemic beliefs when giving instructions or assignments in the Internet-based learning environments. By activating students' metacognitive capability they may utilize the Internet-based information appropriately to perform their academic works.

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Appendix A

Table 4 Exploratory factor analysis for ISEQ

Items	Factors and loadings			
When I need to search for course-related information on the Internet, I believe that….	JU	SO	SP	CE
JU2. I would evaluate the logicality of the course-related knowledge that I find on the Internet.	**.922**	−.018	−.101	−.035
JU1. I would compare knowledge from diverse sources to evaluate the trustworthiness of course-related knowledge that I find on the Internet.	**.919**	−.086	−.165	−.102
JU3. I would check more knowledge sources about the same topic to evaluate course-related knowledge claims that I encounter on the Internet.	**.879**	.036	−.173	−.082
SO2. There are many sources on the Internet that provide most of the knowledge related to my courses (reversed item).	−.006	**.893**	.223	.100
SO3. I could find most of what is true in the field of my study on the Internet (reversed item).	.001	**.823**	.308	.241
SO1. Various sources on the Internet provide the correct answer to questions related to my course work (reversed item).	−.051	**.678**	.219	.359
SP2. The Internet contains simple and concrete knowledge related to study topics in my classes (reversed item).	−.204	.216	**.814**	.135
SP3. The Internet contains a lot of specific information related to study in my classes (reversed item).	−.210	.278	**.794**	.160
SP1. The Internet offers abundant details about topics related to my study (reversed item).	−.094	.215	**.785**	.189
CE3. When I encounter difficulties in my course work, I feel relieved to find experts' statements about them on the Internet (reversed item).	−.133	.097	.147	**.824**
CE2. I could find accurate knowledge about the topics I study on the Internet (reversed item).	−.034	.314	.201	**.798**
CE1. The Internet contains correct answers related to questions about my course work (reversed item).	−.070	**.533**	.157	**.631**
Cronbach's alphas	(.912)	(.850)	(.828)	(.791)

n=150; *CE* certainty of Internet-based knowledge, *SP* Simplicity of Internet-based knowledge, *SO* source of Internet-based knowledge, *JU* justification for Internet-based knowing

Coefficients with absolute values of 0.45 or greater are in boldface

Coefficients in parenthesis are Cronbach's alphas

Appendix B

Table 5 Exploratory factor analysis for SRL

Items	Factors and loadings	
When searching for course-related information in Internet-based environments ….	Enactment SRL	Preparatory SRL
ESRL1. I learned at my own pace.	**.858**	.149
ESRL3. I improved my learning approaches while studying on the Internet.	**.819**	.282
ESRL2. I evaluated or reviewed my learning effectiveness.	**.778**	.346
PSRL1. I set my own learning goals.	.101	**.890**
PSRL3. I explored what I want to learn further.	**.456**	**.688**
PSRL2. I decided on an appropriate strategy while studying on the Internet.	**.539**	**.648**
Cronbach's alphas	(.840)	(.786)

n=150; Coefficients with absolute values of 0.45 or greater are in boldface

Coefficients in parenthesis are Cronbach's alphas

Appendix C

Table 6 Confirmatory factor analysis for ISEQ and SRL

	skew	kurtosis	λ	R^2	δ	CR	AVE
CE1. The Internet contains correct answers related to questions about my course work (reversed item).	0.18	−0.30	0.83	0.69	0.31	0.78	0.55
CE2. I could find accurate knowledge about the topics I study on the Internet (reversed item).	0.41	0.10	0.75	0.56	0.44		
CE3. When I encounter difficulties in my course work, I feel relieved to find experts' statements about them on the Internet (reversed item).	0.60	0.34	0.62	0.39	0.61		
SP1. The Internet offers abundant details about topics related to my study (reversed item).	0.54	0.35	0.79	0.62	0.38	0.84	0.64
SP2. The Internet contains simple and concrete knowledge related to study topics in my classes (reversed item).	0.21	−0.02	0.79	0.63	0.37		
SP3. The Internet contains a lot of specific information related to study in my classes (reversed item).	0.53	0.40	0.82	0.68	0.32		
SO1. Various sources on the Internet provide the correct answer to questions related to my course work (reversed item).	0.21	−0.61	0.65	0.43	0.57	0.85	0.66
SO2. There are many sources on the Internet that provide most of the knowledge related to my courses (reversed item).	0.40	−0.42	0.85	0.72	0.28		
SO3. I could find most of what is true in the field of my study on the Internet (reversed item).	0.26	−0.61	0.92	0.84	0.16		
JU1. I would compare knowledge from diverse sources to evaluate the trustworthiness of course-related knowledge that I find on the Internet.	−0.68	1.02	0.87	0.75	0.25	0.86	0.67

Table 6 (continued)

	skew	kurtosis	λ	R^2	δ	CR	AVE
JU2. I would evaluate the logicality of the course-related knowledge that I find on the Internet.	−0.50	0.63	0.80	0.64	0.36		
JU3. I would check more knowledge sources about the same topic to evaluate course-related knowledge claims that I encounter on the Internet.	−0.52	0.71	0.79	0.63	0.37		
PSRL1. I set my own learning goals.	−0.50	0.06	0.61	0.37	0.63	0.78	0.54
PSRL2. I decided on an appropriate strategy while studying on the Internet.	−0.35	0.05	0.86	0.73	0.27		
PSRL3. I explored what I want to learn further.	−0.62	0.43	0.72	0.52	0.48		
ESRL1. I learned at my own pace.	0.07	−0.46	0.72	0.52	0.48	0.82	0.61
ESRL2. I evaluated or reviewed my learning effectiveness.	−0.12	−0.21	0.81	0.66	0.34		
ESRL3. I improved my learning approaches while studying on the Internet.	−0.39	0.34	0.80	0.64	0.36		

n=240; λ standardized coefficient, R^2 variance explained, δ measure error, *CR* composite reliability, *AVE* average variance extracted

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