Wu, Y.-T. & Tsai, C.-C. (2007). Developing an Information Commitment Survey for assessing students' web information searching strategies and evaluative standards for web materials. *Educational Technology & Society*, 10 (2), 120-132.

Developing an Information Commitment Survey for assessing students' web information searching strategies and evaluative standards for web materials

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ABSTRACT

The idea of "information commitments" refers to both learners' online searching strategies and the evaluative standards that students use to assess the accuracy and usefulness of information in web-based learning environments. Based upon the results of a pioneering and qualitative study on information commitments, this study aimed to develop an Information Commitments Survey (ICS) for assessing the information commitments of 1220 college and graduate students. A series of multivariate multiple regression analyses were also conducted to evaluate the ability of students' evaluative standards as well as their Internet experiences for predicting their online searching strategies. The results showed that the ICS was deemed to be sufficiently reliable for assessing students' information commitments. Gender differences regarding the participants' usage of certain searching strategies were found in this study. Moreover, the students' grade level as well as their Internet experiences played a significant role in their information commitments. The multivariate multiple regression analyses revealed that both the students' use of sophisticated evaluative standards and their Internet experiences significantly predicted the use of sophisticated searching strategies, while their use of less advanced evaluative standards significantly predicted the use of less advanced searching strategies.

Keywords

Information commitments; Information searching strategy; Evaluative standards of web information; Web-based learning

Introduction

During the last decade, web-based instruction has been highly advocated (e.g., Black & McClintock, 1996; Chou & Tsai, 2002; Jonassen et al., 1999) and implemented at all levels of education. Undoubtedly, searching and using web information can greatly enrich students' learning processes and outcomes in web-based learning environments. As a result, learners' information searching in web-based learning environments has been highlighted, and a considerable amount of research has been conducted to explore the nature of learners' information searching on the Internet (e.g., Bilal, 2000, 2001; Hess, 1999; Lazonder et al., 2000; Rouet, 2003; Whitmire, 2003, 2004).

One of the important topics regarding the nature of learners' online searching is which factors influence online searching. In relevant studies, several factors have been identified (e.g., Bilal, 2000, 2001; Wang et al., 2000). Searching strategy is one of them (Pharo & Jarvelin, 2004).

In the process of information searching, the searching strategies learners employ may guide their searching behavior on the Internet. However, when searching information in web-based learning environments, students with expert Internet experience demonstrate better searching strategies than those with novice Internet experience (Tsai & Tsai, 2003). The different online searching strategies used by expert and novice users may lead to different search results, which can be viewed as an important indicator of learners' performance and outcomes derived from web-based learning environments.

Learners may use a variety of searching strategies on the Internet. These online searching strategies may be considered as their approaches to learning in web-based learning environments. Traditionally, educators have proposed the idea of "learning approaches" (or "approaches to learning") to refer to the ways students complete their academic tasks. They have also distinguished students' learning strategies as either deep or surface approaches (Biggs, 1987, 1994; Marton, 1983). The deep approach is characterized by an intention to seek the meaning of the material being studied by elaborating on and transforming it, while the surface approach is characterized by an intention to reproduce the material being studied by using routine procedures (Dart et al.,

2000). Similar to the way students use different learning approaches in a conventional educational environment, learners may also use different learning approaches in web-based learning environments. For example, they may have purposeful thinking, employ an "elaboration" searching strategy to integrate web information from several websites, and try to elaborate and transform web material being studied. Conversely, they may limit their results by reproducing web material employing the "match" strategy, by which they fulfill their searching purposes through finding only a few websites that contain most fruitful and relevant material being studied. This distinction has been proposed in Tsai's (2004) study. Therefore, the searching strategies learners employ to seek web information can be viewed as their learning approaches in processing web-based academic tasks (Wu & Tsai, 2005a). Moreover, it is plausible that learners using the "elaboration" searching strategy can be viewed as employing the deep approach to learning in web-based academic tasks, while learners using the "match" searching strategy can be viewed as employing the surface approach to learning in web-based academic tasks.

In addition, learners' ability to locate websites greatly influences their search results in web-based learning environments (e.g., Lazonder, 1999). Locating an appropriate website is the first phase in the process of online information searching. In relevant studies, it was found that novice and experienced users had different abilities in their locating websites when they search information on the Internet (e.g., Lazonder et al., 2000). It was indicated that experienced learners may have better ability in assessing and judging the websites and the information they had searched, so they can outperform novice users in locating websites. That is, experienced learners may utilize better standards to help them evaluative the websites or information they have searched, and these evaluative standards can also viewed important indicators of their searching results.

As previously mentioned, learners' online searching strategies and their evaluative standards for web materials are two of the important indicators for their searching processes in web-based learning environments. To address these two important issues, Tsai (2004) has defined the idea of "information commitments" for web learners in web-based learning environments. The information commitments proposed by Tsai involve the searching strategies learners employ on the Internet and a set of evaluative standards learners use to assess the accuracy and usefulness of information in web-based learning environments. According to Tsai, learners may employ various evaluative standards for assessing the accuracy and usefulness of web materials in web-based learning environments, and it is plausible to assume that these evaluative standards would lead to different types of information searching strategies on the Internet. In addition, educators have proposed that students' epistemological commitments will guide their conceptual development and knowledge growth. Similarly, students' information commitments are likely guiding their processes and outcomes of knowledge construction in web-based learning environments.

Tsai (2004) also proposed the following theoretical framework for describing web users' information commitments in web-based learning, including the three aspects:
1. *Searching strategy*: The searching strategies that web users employ to seek web information. The possible orientations are "Elaboration" versus "Match." The "Elaboration" indicates that learners may have purposeful thinking when navigating in the web, and try to integrate web information from several websites to find the best fit for their purpose, while the "Match" indicates that learners may be eager to match their searching purposes by finding only a few websites that contain most fruitful and relevant information. Tsai (2004) suggests that these two searching strategies are likely opposite.
2. *Standards for accuracy*: The standards that learners use to verify the accuracy of web information. The possible orientations are "Multiple sources" versus "Authority." Some web users usually use "Multiple sources," such as other websites, prior knowledge, peers, or other printed materials, to examine the accuracy of web information, while others use the "Authority" of the website as a major indicator of accuracy. According to Tsai, these two orientations are likely opposite.
3. *Standards for usefulness*: The standards that learners use to evaluate the usefulness of web information. The possible orientations are "Content" versus "Technical" (functional). "Content" refers to the relevance of web content, while "Technical" refers to the functional and technical issues of the web (e.g., the ease of retrieval of information, the ease of search) as major indicators of usefulness. The orientation toward evaluating the usefulness of web information by "Content" is likely opposite the orientation toward evaluating the usefulness by "Technical" (Tsai, 2004).

Among these three aspects of information commitments, the first one is the information searching strategy used by web users and the others are their evaluative standards for web materials. Tsai (2004) also concluded that the three information commitments, categorized as "Elaboration", "Multiple sources" and "Content", which were expressed by experts, were advanced information commitments, while the others were viewed as less sophisticated.

Clearly, an exploration of learners' information commitments addresses the two aforementioned issues: learners' online search strategies and their evaluative standards for web materials, and the development of a reliable instrument for assessing students' information commitments should be of much importance. To this end, there were two stages for the development of the instrument for assessing learners' information commitments: the exploratory stage and the confirmatory stage. In the exploratory stage, on the basis of Tsai's (2004) qualitative study, the Information Commitments Survey (ICS) was developed, and some exploratory analyses were also conducted; in the confirmatory stage, a series of structural equation modeling (SEM) analyses with LISREL were conducted to reconfirm the reliability and validity of ICS. This study reported the results of the exploratory stage (An earlier version of this study was presented at 2005 World Conference on E-Learning in Corporate, Government, Healthcare, & Higher Education, Vancouver, Canada.), while the results of the confirmatory stage were presented in Wu and Tsai (2005b). In other words, this study aimed to develop the Information Commitments Survey (ICS) for assessing students' information commitments. With this instrument, a group of college and graduate students' information commitments were explored in this study.

Gender differences in Internet-related issues are always highlighted by researchers (e.g., Colley & Comber, 2003; Kadijevich, 2000). As an initial attempt, this study also investigated whether gender differences existed on learners' information commitments. Also, the role Internet experiences as well as grade levels played in college and graduate students' information commitments were also examined. In addition, how different factors influence learners' information seeking behavior and strategies on the Internet has also received lots of attention from researchers (e.g., Bilal, 2000, 2001; Pharo & Jarvelin, 2004). However, still not many studies have been conducted to investigate the factors affect learners' searching strategies (e.g., Tsai & Tsai, 2003). Therefore, through multivariate multiple regression analyses, the current study also examined the ability of the orientations of learners' evaluative standards for web materials as well as their Internet experiences for predicting their online searching strategies.

In sum, this study investigated the following questions:
1. Is the ICS developed in this study sufficiently reliable for assessing students' information commitments?
2. What are the university students' information commitments?
3. Is there any gender difference in university students' Internet attitudes? How?
4. What is the role of university students' Internet experiences in their information commitments?
5. What is the role of university students' grade level in their information commitments?
6. How do learners' evaluative standards for web materials as well as their Internet experiences predict their online searching strategies?

Methodology

Sample

Based upon the results of the previous qualitative study (i.e., Tsai, 2004), this study aimed to develop an instrument for assessing students' information commitments. The sample in Tsai (2004) involved university students. Therefore, the subjects of this study and those of Wu and Tsai (2005b) are also university students. However, the subjects of this study are not the same as those of Wu and Tsai (2005b).

The subjects of this study were 1220 volunteers with different Internet experiences (including 799 males and 421 females) in Taiwan. They were either undergraduate or graduate students (including 833 college students and 387 graduate students), coming from four famous national universities in north Taiwan. Most of them majored in science or engineering, so relatively more males were in the sample. This large sample may have represented many college and graduate students in various science and technology-based universities in Taiwan.

Questionnaire for assessing students' information commitments

To assess students' information commitments in web-based learning environments, a questionnaire, called the Information Commitments Survey (ICS), was administered in this study. This questionnaire was developed on the basis of the theoretical framework proposed by Tsai (2004). The interview responses in Tsai (2004) also provided a foundation for the development of the items in this questionnaire. After the initial construction of the ICS, an expert in the field of web-based instruction commented on it for its face validity, and seven university students were chosen to clarify the wording of each statement.

In this study, Likert-type rating scales were used to gather the data about students' information commitments. There has been a continuing and fierce debate on the use of Likert-type rating scales (Knapp, 1990). Although the response categories in Likert scales have a rank order and should be viewed as ordinal-level measurement, it has become common practice to assume that Likert-type categories constitute interval-level measurement as well as the intervals between values are equal (Jamieson, 2004). On the issue of the usage of Likert-type rating scales, two opposite positions have been held by researchers. Some researchers have argued that the aforementioned use of Likert scales may led to error in interpreting data and the relations inferred from data, while others have proposed that the danger is probably not as grave as it has made out to be and the results we get from using summated scales and assuming equal intervals are quite satisfactory (e.g., Kerlinger & Lee, 2000). For the pragmatic considerations, the perspective adopted in this paper is the same as the latter. However, caution must be used when interpreting the results.

The ICS included of six scales (initially a total of 38 items), which were presented with bipolar strongly agree/ strongly disagree statements in a six-point Likert scale (i.e., strongly agree, agree, somewhat agree, somewhat disagree, disagree and strongly disagree). The use of six-point Likert scale was to avoid students' selection of totally neutral position for many items. A detailed description of the six scales and sample items from each scale were presented below:

1. *Elaboration as searching strategy scale (Elaboration)*: measuring the extent to which students will have purposeful (metacognitive) thinking or integrate web information from several websites to find the best fit that fulfilled their purpose.
2. *Match as searching strategy scale (Match)*: investigating the extent to which students will be eager to find only a few websites that contain the most fruitful and relevant information. Their strategy is oriented to match searching purposes.
3. *Multiple sources as correctness scale (Multiple sources)*: measuring the extent to which students will validate the correctness of unknown information on web by relating to other websites, prior knowledge, peers, or other printed materials.
4. *Authority as correctness scale (Authority)*: assessing the extent to which students will examine the accuracy of unknown information in web-based learning environments by the authority of the websites or sources.
5. *Content as usefulness scale (Content)*: measuring the extent to which students will assess the usefulness of the information viewed in web-based learning environments by the relevancy of its content.
6. *Technical issues as usefulness scale (Technical)*: assessing the extent to which students will judge the usefulness of the information viewed in web-based learning environments by the ease of retrieval, the ease of searching or the ease of obtaining information. Therefore, their standard for evaluating web information is more related to some technical issues.

In this study, the questionnaire was presented in digital format, and the participants were asked to fill out their response on the web. Moreover, the questionnaire was presented in Chinese when undertaking this study, and the questionnaire items, shown in this paper, were translated by the authors.

Results

Factor analysis

In this study, exploratory factor analysis was conducted to clarify the structure of the information commitments in web-based learning environments. The principle component analysis was used as the extraction method, and the rotation method was varimax with Kasier normalization. An item was retained only when it loaded greater than 0.50 on the relevant factor and less than 0.50 on the non-relevant factor.

The factor analysis revealed that the subjects' responses on the questionnaire were grouped into six factors, which were: "Elaboration", "Match", "Multiple sources", "Authority", "Content", and "Technical". The six factors were exactly the same as those initially proposed by Tsai (2004). All the eigenvalues of the six factors were larger than one, and these factors accounted for 65.30% of variance. There were respectively 5, 3, 3, 4, 5, and 4 items in these six scales. The items and responding scales are shown in the Appendix, and the factor loadings for the retained items are presented in Table 1 (To match the theoretical framework of ICS, the factors are not reported in the order of their extractions.). The reliability (alpha) coefficients for these scales respectively were 0.84, 0.74, 0.72, 0.82, 0.88, and 0.76, and the overall alpha was 0.80. Therefore these scales were deemed to be sufficiently reliable for assessing students' information commitments in web-based learning environments.

Table 1: Rotated factor loadings and Cronbach's α values for the six factors (scales) of ICS (n=1220)

Item	Factor 1: Elaboration	Factor 2: Match	Factor 3: Multiple	Factor 4: Authority	Factor 5: Content	Factor 6: Technical

			sources			
Factor 1: *Elaboration* α=0.84						
Elaboration 1	0.76					
Elaboration 2	0.68					
Elaboration 3	0.76					
Elaboration 4	0.72					
Elaboration 5	0.72					
Factor 2: *Match* α=0.74						
Match 1		0.81				
Match 2		0.80				
Match 3		0.74				
Factor 3: *Multiple sources* α=0.72						
Multi. Sour. 1			0.77			
Multi. Sour. 2			0.86			
Multi. Sour. 3			0.63			
Factor 4: *Authority* α=0.82						
Authority 1				0.80		
Authority 2				0.79		
Authority 3				0.79		
Authority 4				0.73		
Factor 5: *Content* α=0.88						
Content 1					0.75	
Content 2					0.81	
Content 3					0.83	
Content 4					0.77	
Content 5					0.71	
Factor 6: *Technical* α=0.76						
Technical 1						0.64
Technical 2						0.82
Technical 3						0.79
Technical 4						0.72
Eigen-value	3.1	1.33	1.13	2.10	6.32	1.68
% of variance	12.96	5.53	4.70	8.77	26.33	7.01

Overall α = 0.80, total variance explained is 65.30%

Students' scores on the scales

Table 2 shows students' average item scores and standard deviations on the six scales of the ICS. According to Table 2, students scored highest on the "Content" (an average of 5.11 per item), followed by "Elaboration" (an average of 4.90 per item), "Authority" (an average of 4.66 per item), "Multiple sources" (an average of 4.49 per item), "Technical" (an average of 4.03 per item), and "Match" (an average of 2.94 per item). The results indicated that the students, on average, did not agree that they often used the "match" searching strategy.

Table 2: Students' scores on the scales of ICS (n=1220)

Scale	# of items	Item mean	SD
Elaboration	5	4.90	0.65
Match	3	2.94	1.02
Multiple sources	3	4.49	0.76
Authority	4	4.66	0.74
Content	5	5.11	0.58
Technical	4	4.03	0.88

Gender differences on information commitments

Table 3 shows that the male students and the female students in this study only had significant differences in terms of their scores on the "Match" scale ($p<0.01$). It indicated that, compared with the female students, the male students in this study were more oriented to use the "match" searching strategy when seeking information on the web.

Table 3: Gender comparisons on the scales of ICS

Scale	Gender	Mean	S.D.	t
Elaboration	Male	4.89	0.66	-0.62
	Female	4.91	0.62	
Match	Male	3.00	1.03	2.99**
	Female	2.82	0.98	
Multiple sources	Male	4.50	0.78	0.96
	Female	4.46	0.73	
Authority	Male	4.67	0.76	0.68
	Female	4.64	0.69	
Content	Male	5.13	0.60	1.27
	Female	5.08	0.55	
Technical	Male	4.04	0.89	0.50
	Female	4.01	0.85	

** $p < .01$

The role of Internet experiences in information commitments

In this study, the amount of the participant's online hours on average per week was regarded as his/her Internet experience. According to the students' online hours on average per week, they were divided into five groups of different Internet experiences: less than 14 hours (n=241), 14-21 hours (n=273), 21-28 hours (n=179), 28-35 hours (n=221), and finally more than 35 hours (n=306). An analysis of the role of Internet experiences in the scales of information commitments is presented in Table 4.

Table 4: Students' responses on the ICS among groups of different Internet experiences

Online hours per week	Elaboration (mean, S.D.)	Match (mean, S.D.)	Multiple sources (mean, S.D.)	Authority (mean, S.D.)	Content (mean, S.D.)	Technical (mean, S.D.)
(1) Less than 14 hours (n=241)	4.79 (0.66)	3.09 (0.96)	4.40 (0.73)	4.58 (0.72)	5.00 (0.60)	3.96 (0.88)
(2) 14-21 hours (n=273)	4.83 (0.61)	2.85 (0.97)	4.45 (0.79)	4.66 (0.73)	5.11 (0.53)	3.96 (0.85)
(3) 21-28 hours (n=179)	4.94 (0.61)	2.87 (1.00)	4.54 (0.71)	4.68 (0.67)	5.15 (0.57)	4.07 (0.85)
(4) 28-35 hours (n=221)	4.92 (0.66)	3.06 (1.07)	4.56 (0.74)	4.69 (0.76)	5.14 (0.60)	4.11 (0.87)
(5) more than 35 hours (n=306)	4.99 (0.67)	2.84 (1.05)	4.50 (0.80)	4.70 (0.77)	5.16 (0.61)	4.07 (0.92)
F (ANOVA)	4.27**	3.54**	1.65	1.11	3.24*	1.61
Scheffe Test	(6)>(2)				(6)<(2)	

* $p < .05$, ** $p < .01$

As shown in Table 4, the ANOVA tests revealed that the students' Internet experience played a role in their use of the "elaboration", and "match" searching strategies, and the use of the evaluative standard, "Content". A series of Scheffe tests (post hoc tests) further indicated that the students having more than 35 hours of using the Internet on average per week were more prone to utilize the "Elaboration" searching strategy and the evaluative standard, "Content ". It implied that those who had more time of using the Internet, in general, tended to be more oriented to utilize sophisticated searching strategy (i.e., "Elaboration") and certain advanced evaluative standards for assessing the usefulness of the materials in web-based learning environments (i.e., "Content").

The role of grade level in information commitments

The subjects of this study were also divided into three groups: the freshmen and sophomore group (n=291), the junior and senior group (n=542), and the graduate student group (n=387). Then, a series of ANOVA test analyses were conducted in this study, and the results are summarized in Table 5

Table 5: Students' responses on the ICS among different grade levels

Grade	Elaboration (mean, S.D.)	Match (mean, S.D.)	Multiple sources (mean, S.D.)	Authority (mean, S.D.)	Content (mean, S.D.)	Technical (mean, S.D.)
(1) Freshmen & Sophomore	4.84(0.69)	2.98(0.99)	4.42(0.87)	4.62(0.77)	5.10(0.65)	3.94(0.87)
(2) Junior & Senior	4.89(0.62)	2.94(1.05)	4.45(0.73)	4.69(0.69)	5.09(0.55)	4.04(0.87)
(3) Graduate	4.95(0.64)	2.90(0.99)	4.59(0.70)	4.65(0.77)	5.14(0.58)	4.08(0.89)
F(ANOVA)	2.35	0.51	5.19**	0.75	0.95	2.30
Scheffe Test			(3)>(1) (3)>(2)			

** $p < .01$

As revealed in Table 5, the ANOVA tests showed that the participants' grade level played a role only in their scores on the "Multiple sources" scale. Moreover, a series of Scheffe tests (post hoc tests) further indicated that the students in the graduate group tended to score statistically higher than those in the other two groups did on the "Multiple sources" scale. However, the students of the junior and senior group did not score significantly higher than those in the freshmen and sophomore group did on this scale. In sum, the graduate students may be more oriented to utilize multiple sources to assess the correctness of the materials in web-based learning environments than the college students.

Predicting students' information searching strategies

One of the major purposes of this study was to examine the predictive power of using learners' evaluative standards for web materials to predict their online searching strategies. To this end, multivariate multiple regression analyses, using Ordinary Least Square method (OLS), were conducted as the major statistical method. The participants' responses on the four ICS scales related to students' evaluative standards for web materials (i.e., "Multiple sources", "Authority", "Content", and "Technical") were perceived as the predictors. In addition, students may better develop their searching strategies if they have more opportunities to search information on the web. Therefore, the participants' Internet experience (i.e., their online hours per week) was also included as a predictor for their usage of two different searching strategies (i.e., "Elaboration" and "Match") in this study.

Table 6: Multivariate multiple regression estimates for predicting students' searching strategies (n=1220)

Predictors	Elaboration		Match	
	β	Std. error	β	Std. error
Multiple sources	0.29**	0.02	-0.11*	0.04
Authority	0.03	0.02	0.17**	0.04
Content	0.44**	0.03	-0.42**	0.05
Technical	0.01	0.02	0.34**	0.03
Online hours per week	0.02*	0.01	-0.03	0.02
R-square	0.39		0.14	
Breusch-Pagan test of independence (x^2)	46.62**			

* $p < .05$; ** $p < .01$

Table 6 showed that "Content" (β=0.44, p<.01), "Multiple sources" (β=0.29, p<.01), and "students' online hours per week" (β=0.02, p<.05) could significantly and positively predict "Elaboration", and they explained 39% of students' usage of the "elaboration" searching strategy. In addition, "Technical" (β=0.34, p<.01) and "Authority" (β=0.17, p<.01) were both significantly positive predictors for "Match", while "Multiple sources" (β=-0.11, p<.05) and "Content" (β=-0.42, p<.01) were significant but negative predictors for "Match". Totally, these four factors accounted for 14% variance. In addition, the multivariate multiple regression analyses also provide a way to test whether the two equations are related. By the Breusch-Pagan test of independence, it was found that

"Elaboration" and "Match" were significantly and negatively correlated (r=-0.2, p<.01). Therefore, it was appropriate to estimate these two equations jointly, rather than independently.

In sum, the results in Table 6 indicated that learners, who were more oriented to assess the accuracy and usefulness of web materials by multiple sources and their content, and those who searched information on the Internet frequently, were more likely to employ the "elaboration" searching strategy in web-based learning environments. On the other hand, learners, who were more inclined to evaluate the accuracy and usefulness of web information by its authority and technical issues, and those who were less inclined to judge the accuracy and usefulness of web information by multiple sources and its content, were more possible to use the "match" searching strategy. In addition, the significantly negative correlation between "Match" and "Elaboration" also implied that they were likely opposite searching strategies.

Discussion

In this study, an instrument for assessing students' information commitments in web-based learning environments (i.e., the Information Commitments Survey; ICS) was developed. The results showed that the ICS developed in this study was deemed to be sufficiently reliable for assessing students' information commitments in web-based learning environments. Wu and Tsai (2005b), by another sample, have also conducted confirmatory factor analysis to examine ICS, and shown adequate reliability for the instrument. In this study, some gender differences and grade-level differences on information commitments were also found. Moreover, through multivariate multiple regression analyses, some predictors for students' searching strategies on the Internet were also revealed. These results are discussed below.

Gender differences in Internet-related issues have always been highlighted by researchers (e.g., Colley & Comber, 2003; Kadijevich, 2000). In this study, gender difference was also found in the students' use of the information commitment categorized as "Match". The male students were significantly more oriented to use the "match" searching strategy than did the females. "Match" is a less sophisticated searching strategy. The finding is worthy of noting, because it contradicted to most studies regarding the relationships between technology and gender, suggesting that the males almost outperform the females in computer-related issues (e.g., Durndell & Haag, 2002; Tsai *et al*., 2001). Thus, further investigations should be conducted to explore the gender differences in searching strategies and behaviors.

In their previous study, Metzger *et al*. (2003) have revealed that many college students may depend on the Internet to provide accurate information without ensuring the accuracy of the information they obtain. The college students may not verify the information they have searched, implying that they tend to evaluate the correctness by its authority. In this study, the graduate students were more oriented to utilize multiple sources to judge the correctness of the materials in web-based learning environments than college students did. It may be likely due to their course work and academic tasks to be completed and professional training. However, further studies are needed to confirm this assertion. The finding above is also consistent with the perspective proposed by Metzger *et al.* (2003) that college students' web information verification behaviors should be more emphasized. That is, the importance of assessing the accuracy of web materials should be highlighted for students in web-based learning environments.

Tsai (2004) has proposed that "Elaboration" and "Match" were likely two opposite searching strategies. The results derived from the multivariate multiple regression analyses demonstrated a significantly negative correlation between "Elaboration" and "Match", implying that they were possibly opposite searching strategies. Therefore, the results above were consistent with Tsai's (2004) perspective.

The results in this study seem to provide some empirical evidence to support an aforementioned perspective that the searching strategies learners employ on the Internet may be viewed as their learning approaches in web-based learning environments. In this study, it was revealed that "Elaboration" and "Match" were possibly opposite searching strategies. In addition, Tsai (2004) has proposed that "Elaboration" can be viewed as a sophisticated searching strategy, while "Match" should be viewed as a less sophisticated searching strategy. As the idea of learning approaches in traditional educational context, the web searching strategies, in which learners employ to seek web information, can be viewed as their learning approaches in web-based academic task (a specific educational context). That is, learners' "elaboration" searching strategy can be viewed as their usage of the *deep approach* to learning in web-based academic tasks, while students' "match" searching strategy can be viewed as their use of the *surface approach* to learning on the web. However, further studies are needed for examining this perspective.

In Tsai's (2004) perspectives, the three information commitments, categorized as "multiple sources", "Content" and "Elaboration", which were expressed by experts, were advanced information commitments, while the others were less sophisticated. The results in this study also provided some empirical evidence for his perspectives. As previously mentioned, this study has revealed that "Elaboration" and "Match" were two opposite searching strategies, and "Elaboration" can be viewed as a sophisticated searching strategy, while "Match" should be viewed as a less advanced one. This study also found that learners, who were more oriented to assess the accuracy and usefulness of web information by multiple sources and content, and those who searched information on the web more frequently, tended to employ the "elaboration" searching strategy in web-based learning environments. On the other hand, learners, who were more inclined to evaluate the accuracy and usefulness of web information by its authority and technical issues, and those who were less inclined to judge its accuracy and usefulness by multiple sources and content, were more inclined to use the "match" searching strategy. In other words, when searching in web-based learning environments, experts commonly tend to express the following three information commitments: "Multiple sources", "Content", and "Elaboration", while novices are more oriented to have the other three information commitments: "Authority", "Technical", and "Match".

In addition, similar to the findings about the significant relationships between students' epistemologies and their approaches to learning (e.g., Edmondson & Novak, 1993; Tsai, 1998, 1999), it was found in this study that learners' evaluative standards for web materials, shaping some epistemological standards for web information, can be viewed as important indicators for predicting their searching strategies in web-based learning environments. Therefore, further empirical studies are suggested to carefully examine the interplay between learners' evaluative standards for web materials and their online searching strategies. The studies completed by Whitmire (2003, 2004) and Hofer (2004), Tsai and Chunag (2005) can be viewed as some initial attempts for this research issue. Recently, Braten and Stromso (2006) have also reported that student teachers' Internet-based learning activities (including Internet-search activities and Internet-communication activities) could be predicted by their epistemological beliefs, interest, and gender. In this study, we also found that learners' evaluative standards for web materials, shaping some epistemological standards for web information, can be viewed as important indicators for predicting their online searching strategies. Tsai (2004) also asserted that learners' information commitments should be related to their epistemological beliefs. As reported in Braten and Stromso (2006) that learners' epistemological beliefs is an important predictor for their Internet-based learning activities, their information commitments may also constitute an important predictor for their Internet-based learning activities. However, empirical research is needed to confirm this perspective. In addition, further studies can be also conducted to investigate the relationships between learners' epistemological beliefs and their information commitments.

Furthermore, this study showed that students' frequency of using the Internet per week was also a significant predictor for their use of the "elaboration" searching strategy. That is, the more time learners spend in searching information on the Internet, the more learners may be oriented to develop a sophisticated searching strategy (i.e., "Elaboration"). To help learners develop a more advanced searching strategy, educators should try to provide them with more opportunities to search information in web-based learning environments. Thus, they are expected to attain better performances and learning outcomes in web-based learning.

Kuhn and Weinstock (2002) described the progression of learners' epistemological beliefs in the sequence of the following levels: realist, absolutist, multiplist, and evaluativist. In their viewpoints, learners, who have developed their epistemological beliefs in the "evaluativist" level, will examine and compare claims according to the merits of argument and evidence. In this study, the graduate students tended to express a more significant tendency to use multiple sources to evaluate the accuracy of the information they searched. In other words, the graduate students in this study might have developed their epistemological beliefs in the "evaluativist" level, in which they judged the correctness of the web information they had searched by assessing or contrasting multiple sources of information. Also, Perry (1970) has suggested a structural, systematic progression of an individual's epistemological beliefs in the following stages: dualism, multiplicity, relativism, and commitments within relativism. In this study, the graduate students in the perspective of using multiple sources in verifying web information seemed to hold more advanced information commitments than college students did. The information commitments shown by web users might be similar to Perry's (1970) perspectives on epistemological beliefs, and could be conceptualized as a developmental process that proceeds in a patterned, stage sequence. However, it requires more follow-up research, especially a series of longitudinal studies, conducted to trace a group of students' progression in their information commitments across academic years, and then to examine whether their of information commitments can be illustrated as a developmental sequence in a patterned, developmental sequence.

Hofer (2004) has argued that student use of the Internet as a medium for learning involves a host of epistemological judgments that deserve more attention, and students' metacognitive aspects of epistemological understanding during online searching should be trained to enhance their ability to think critically about seeking and evaluating. Tsai (2001b) also suggested an active and complicated interplay among epistemological beliefs, critical thinking and metacognitive processes in learning activities. Therefore, the interrelationships among learners' information commitments, metacognitive engagement and their learning outcomes in web-base learning environments, and how these commitments guide their metacognitive awareness, usage of web information and learning should also be investigated. The current study, clearly, is an initial attempt for these issues.

Study limitation

As aforementioned, this study is one of the initial attempts to explore university students' information commitments, and the findings in this study may be helpful for educators to get some insights into university students' information commitments. However, it should be noticed that the findings in this study were obtained through the use of Likert-type rating scales. Therefore, the interpreting of the findings in this study should be careful. Further studies, with different statistical methods for dealing with the gathered data, such as "Rasch analysis" (e.g., van Alphen et al, 1993), are also suggested to reconfirm the findings in this study.

Acknowledgement

The funding of the research work was supported by National Science Council, Taiwan, under grant numbers NSC 93-2524-S-009-003, and 95-2511-S-011-004-MY3.

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Appendix. Items of the Information Commitments Survey (ICS)

Elaboration as searching strategy (Elaboration)

When I search information on the Internet,

1. I am used to summarize a variety of information.
2. I can use some acquired information for advanced search to find the most-fit information.
3. I can integrate the information obtained from a variety of websites.
4. I can keep reminding myself about the purpose of my searching.
5. I can compare different information from related websites (or pages).

Match as searching strategy (Match)

When I search information on the Internet,

1. I usually only use search engine to find the most-fit websites (or pages).
2. if I find the first relevant website, I will not search others.
3. I am eager to find a single website that contains the most fruitful information.

Multiple sources as correctness (Multiple sources)

When I view some information unknown on the Internet,

1. I will discuss with teachers or peers, and then to judge whether the information is correct.
2. I will explore relevant content from books (or print materials), and then to evaluate whether the information is correct.
3. I will try to find more websites to validate whether the information is correct.

Authority as correctness (Authority)

When I view some information unknown on the Internet,

1. I will believe in its accuracy if the information is posted in famous websites.
2. I will believe in its correctness if the information appears in government websites.
3. I will believe in its accuracy if the information is posted in professional (official) websites.
4. I will believe in its correctness if the information appears in some websites recommended by experts.

Content as usefulness (Content)

When I view or navigate information on the Internet,

1. if its content fits my searching goal, I will think the information is useful to me.
2. if it can provide more related links, the information for me is useful.
3. if it can help me search relevant information further, I will think the information is useful to me.
4. if it is closer to my searching purpose, I will more believe in its usefulness.
5. if it is highly related to my intended searching content, the information for me is useful.

Technical issues as usefulness (Technical)

When I view or navigate information on the Internet,

1. if it is presented by animation, I will think the information is useful to me.
2. if it does not take much time to be retrieved, the information is useful to me.
3. if it does not require password or registration, I will think the information is useful to me.
4. if it is shown in more beautiful websites, I will believe in its usefulness.

Note: The same questionnaire is also presented in Wu and Tsai (2005b).