

The Model of Strategic e-Learning: Understanding and Evaluating Student e-Learning from Metacognitive Perspectives

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ABSTRACT

This paper presents the Model of Strategic e-Learning to explain and evaluate student e-learning from metacognitive perspectives. An in-depth interview, pilot study and main study are employed to construct the model and develop an instrument—the Online Learning Strategies Scale (OLSS). The model framework is constructed and illustrated by four dimensions of characteristics of e-learning environments and three core domains (perceived-skill, affection and self-regulation) of student e-learning strategies. This study also tries to identify and analyze elements corresponding to each domain strategy. Based on this model, the OLSS finally contains 20 items with good construct validity and reliability. This instrument provides a diagnostic instrument for e-learning researchers, system designers, curriculum developers and instructors to evaluate students' e-learning strategies in their experiment, design and development. This study concludes by presenting several future research directions.

Keywords

E-learning, e-Learning model, Evaluation, Strategic e-learning, e-Learning strategies

Background

During the past decade, researchers, schools and governments around the world have advocated enhancing student learning by using digital tools, i.e. the e-learning. The biggest advantage of e-learning is that it gives students active learning opportunities. Students are believed to be able to gain greater control over their own learning in e-learning compared to traditional learning. Growing numbers of online instructional systems have been developed during the recent years; however, studies of online instructions provided in these systems did not exhibit consistent results in terms of improving or supporting student learning. This may be related to student learning strategies used for Internet-based learning (McCormack & Jones, 1998). When students shift their learning from traditional to online learning environments, they are challenged by different learning and interaction methods. If students adopt effective and efficient approaches for e-learning, they can enhance both their e-learning achievement and their e-learning motivation.

Previous researches have noticed the role of learning strategies in Internet-based learning. It has been observed that student learning strategy is one of the factors impacting student online learning achievement (Shih, Ingevitzen, Pleasants, Flickinger & Brown, 1998). Wallace (2000) and his colleagues indicate that online information seeking is a complex and difficult process for students and developing students' understanding of content through use of the Internet is a challenge for students and teachers. Tsai and Tsai (2003) further report that student Internet self-efficacy and metacognitive strategies play important roles in student online inquiry learning. Ligorio (2001) considers that the various communication styles integrated into online learning activities are valued only when students are aware of the technologies and tools associated with each communication style. For example, Frank and his colleagues (2003) examined the process of online learning via e-mail for elementary students and concluded that students encountered technological problems and social problems. Technological problems included anxiety regarding using computers for learning, difficulties in using email and the Internet to complete homework, and the difficulty of solving problems when computer systems are down. Regarding social problems, the most significant social problems related to feelings of isolation resulting from online learning. Most elementary students still needed parental help to finish their homework. Lee (2001) examined the styles of learners accustomed to online learning environments and further found that students who recognized online learning may have poor online learning achievement. These literatures imply that online learners are challenged by new problems which they may have never encountered before in traditional learning environments; for example, how to handle the feelings of isolation and how to solve online technological problems by themselves. Recent research explore online inquiry-based learning and claim that higher-level cognitive strategies facilitate student knowledge construction (Salovaara, 2005) and further develop

scaffoldings to enhance the development of student metacognitive strategies (Kramarski & Gutman, 2006; Quintana, Zhang & Krajcik, 2005). These researches reveal that new approaches and cognitive strategies may need to be developed particularly for online learning circumstances. Furthermore, positive attitude towards online learning is revealed not sufficient for successful online learning. This suggests that, in addition to affective variables, online learning may be simultaneously influenced by cognitive and behavioral variables. According to the above, students may be required for new learning strategies and skills so that they can become effective and successful online learners.

Features of Internet-based learning environments require online learners for new approaches to achieve their goals or requirements of online learning; however, research literature regarding online learning strategies remains extremely limited. Miller and Miller (2000) pointed out three features of web-based learning environments that differed significantly from traditional learning environments: (1) associative, nonlinear, and hierarchical structure; (2) enhanced multimedia capabilities; and (3) various synchronous and asynchronous communication opportunities. Two problems that limit the use of hypertext environments are unrestricted learner control of sequencing and lack of learner ability to meaningfully integrate unstructured information (Jonassen, 1991). Collis and Meeuwssen (1999) indicated that students need to take responsibility for increased control of learning process and positive attitude to achieve active learning in such an open-ended learning environment as the Internet. They further suggested that learning how to learn on the Internet should include reflection skills, planning skills, study skills, search skills, application skills, and self-evaluation skills. MacGregor (1999) reported that learners adopt different learning approaches in hypertext learning environment. Linn, Davis and Bell (2004) proposed the knowledge integration perspective of e-learning and emphasized on the designs of scaffoldings of idea recognition, connection and monitoring skills. These above technological, cognitive and metacognitive skills are critical for successful e-learning. The inability of students to transfer their learning strategies directly from traditional to online learning environment may result in different performances (Mehlenbacher, Miller, Covington, & Larsen, 2000). Although some researchers (for example, Miller & Miller, 2000) have already noticed the importance of e-learning strategies, an integrated and complete model to profile students' e-learning strategies is still lack in related literature.

With high degrees of freedom, the Internet-based learning environments may favor students who possess mature computer skills and metacognitive skills (Park & Hannafin, 1993; Tsai & Tsai, 2003). These skills are both explicitly and implicitly exhibited in their learning strategies (Miller & Miller, 2000; Weinstein & Mayer, 1986). Therefore, an integrated and complete model describing student online learning strategies is necessary for deeply understanding students' e-learning approaches and systematically assessing variables influencing e-learning achievement. Such a model can help researchers explore many research topics including identifying effective learning strategies for online learning; identifying important elements that should be considered as factors when understanding and describing student online learning strategies; identifying the impact of student online learning strategies on their online learning achievements; developing methods for evaluating and diagnosing student mature levels of online learning strategies; and developing methods for helping students acquire new learning strategies. To explore the above research issues, this study proposes a theoretical model for understanding student learning strategies used in online learning environments. In addition, this work presents the development of an instrument for assessing student online learning strategies. Besides, e-learning may involve various digital technologies including the Internet, CD-ROM, PDA, interactive TV or satellite broadcast... and so on. This study discusses e-learning focusing on learning via the Internet involved learning interfaces. Therefore, terms including e-learning, Internet-based learning and online learning are used interchangeably in this study.

Theoretical Framework

Metacognitive Perspectives

Metacognition refers to the self-awareness of individuals about their knowledge and self-understanding, self-control and self-manipulation of the process of their own cognition (Osman & Hannafin, 1992). Students with high metacognitive abilities not only are clearly aware of their learning objectives, but also know effective and efficient approaches to construct knowledge; therefore, such students can monitor their own learning and utilize various learning strategies, thus enhancing learning achievement and learning motivation (Pressley & Wolshyn, 1995). Park and Hannafin (1993) even observed that students require higher metacognitive skills in less-structured learning environments. Although instructors can accommodate students with different levels of metacognitive skills by

selecting suitable teaching objectives and activities (Miller & Miller, 2000), some researchers (for example, McKeachie, 1988; Weinstein & Mayer, 1986) emphasized on particular curriculum design and instruction to develop student metacognitive abilities and explore the effects of providing scaffolding for learning strategies on learning achievement and motivation. Some strategy-embedded curricula were supported by long term observation and examination (Weinstein, 1994; Weinstein & McCombs, 1998). Therefore, Weinstein (1994; 1998) proposed the concept of “strategic learning” to explain student learning strategies based on metacognitive perspectives.

Strategic Learning

The strategic learning (Weinstein, 1994; 1998) is focused on students as active, self-determined individuals who process information and construct knowledge. The model has the learner at its core, and around this core are three interactive components that explain successful learning: *skill*, *will*, and *self-regulation*. *Skill* refers to the various actions or thinking processes related to recognition of key concepts and processes and how meanings are constructed. *Will* indicates individual learning attitude, acceptance of new information, will to concentrate and make efforts, and anxiety toward his/her own learning performance. *Self-regulation* (Zimmerman, 1989) describes how individuals manage their personal learning process, especially how to plan, monitor, focus on and evaluate their own learning. Categorized by the above three components, learning strategies here refers to any *thoughts, behaviors, beliefs* or *emotions* that facilitate the acquisition, understanding or later transfer of new knowledge and skills. Ertmer and Newby (1996) recognize strategic learning as a feature of expert learning. Strategic learning stresses the need of learners to clearly realize their individual advantages and disadvantages regarding all aspects of strategies to enable them to better manage their learning. Furthermore, to diagnose the strengths and weaknesses of students in relation to the above aspects of learning strategies, a diagnostic assessment instrument, “Learning and Study Strategies Inventory (LASSI), was developed by Weinstein and her colleagues (1988; 1990). Meanwhile, the LASSI is validated in the in-depth analysis conducted by Cano (2006), which involved conceptually grouping LASSI subscales into three categories: *affective* strategies, *goal* strategies and *comprehension monitoring* strategies. Another similar instrument, the Motivated Strategies for Learning Questionnaire (MSLQ), developed by Pintrich and his colleagues (1991) is designed to investigate student motivation and their use of different learning strategies.

Collis and Meeuwsen (1999) have identified key differences among students in their use of the Internet for learning. They began to consider the sorts of skills and approaches to online learning that students need to make creative and constructive use of the learning potential of the WWW. Particularly, they described the challenges of online environments with regard to “learning to learn” components, including articulation and reflection, planning skills, study skills, finding and applying relevant examples, and self-evaluation. For example, the technological aspects of Internet-based learning environments may be unfamiliar to students, preventing students from articulating their experiences. Decomposing an online learning task into a sequence of subtasks and making realistic estimates of the time and effort required for each subtask in online learning environments may be too complex for students to plan and manage their own online learning. New tools and terminology therefore must be mastered to do something as simple as making a margin note. Choosing meaningful information from the Internet and integrating it to learning domains may represent another challenge for all online learners. As a result, a new model may be required to profile the online learning strategies used by students in Internet-based learning environment.

Based on the above rationale, this study proposes the Model of Strategic e-Learning by modifying the construct of strategic learning of Weinstein (1994; 1998) based on the arguments of Collis and Meeuwsen (1999).

The Model of Strategic e-Learning

To develop the model, this study begins with answering the following two research questions: (1) What are the distinct characteristics of online learning environment? (2) What are the characteristics of online learning strategies? According to the strategic learning (Weinstein, 1994), the former is analyzed in four dimensions: *nature of e-learning tasks*, *online social supports*, *available online resources* and *online learning systems*. Meanwhile, the latter is analyzed by conducting an in-depth interview emphasizing student online learning strategies in the three domains of *skill*, *will* and *self-regulation*.

Features of Online Learning Environment

Online learning environment is not involved just one environment but several environments including the WWW, e-mail, asynchronous discussion forum (e.g. BBS, mailing list and newsgroup) and synchronous discussion forum (e.g. online chat room, video conference and online games)... and so on. The related literature of Internet-based learning environment (Miller & Miller, 2000; Linn, Davis & Bell, 2004) is analyzed based on the four environmental dimensions which are recognized from the construct of strategic learning (Weinstein, 1994) and stated in the above paragraph. Finally, four characteristics of online learning environment are identified as follows:

1. *Flexible time and space*: The most significant revolution of e-learning is that e-learning overcome the limits of time and place for learning. Online learning tasks can be performed at any time or place provided they have Internet access. Online learning environments thus differ significantly from traditional learning environments, where teachers and students must meet regularly at a specific place and time. Online learners become more free, flexible and convenient in time and location of learning. That is, students gain more locus of control than learning in traditional environments. However, are students prepared for this freedom? Are they aware of their responsibilities of their online learning? Are they able to set goals and make plans for their online learning? Are they able to self-control and self-monitor their learning process via the Internet? Are they able to concentrate on their learning tasks and manage their time for online learning? All of the questions may challenge novice online learners in their control strategies and metacognitive skills such as self-awareness, self-evaluation, self-monitoring, self-control and time management.
2. *Indirect Social Interaction*: The absence of face-to-face interaction is one of most criticized features of learning via the Internet, although it may reduce the anxiety of some students regarding answering questions in traditional classrooms. The isolation of online learning was one of the main frustrations associated with online learning before synchronous communication technologies (e.g. video/audio conference) significantly accelerated the processing of multimedia signals. And asynchronous communication applications (e.g. online discussion board, e-mail, blog, BBS...etc.) are still used popularly in schools. That is, indirect interactions are still the main streams in e-learning. Besides, online social supports may come not only from teachers, peers and friends but also from unknown individuals around the world. The roles of teachers in an online learning environment become more like facilitators and helpers. In particular, the beliefs and expectations of online teachers may not be perceived by students as easily and strongly as in traditional classrooms. The above challenges require students for new strategies to cooperative and negotiate with others via the Internet. They also need to understand the change of teacher's role and possess new attitudes, motivation and approaches to interact with varied online social supports.
3. *Abundant Information Resources*: The abundance and diversity of information resources is the greatest advantage of Internet-based learning. Students can immediately retrieve information around the world only if they link to the Internet. However, the quality of online information are varies significantly and information stability and authority differs markedly from that in a traditional classroom. Online learners can easily and quickly search for information they need but simply copy and paste it for their assignments. Students need to know not only how to search for information via the Internet but also how to evaluate, integrate and judge the information provided on the Internet. How to process and utilize online information is a new issue for online learners. Therefore, students require mature online information search strategies and mature online information commitment (Wu & Tsai, 2005) for meaningful online learning. In addition, the numerous of online information could result in anxiety towards online information, for example, individuals may feel anxious because they think online information is too much to read. This may be another challenge needed to be handled by some online learners due to the abundant information resource provided on the Internet.
4. *Dynamic Learning Interfaces*: Online learning involves using Internet technology to create a learning platform for interactions among students and teachers. Due to the technology advances rapidly, the interfaces changing with time dynamically is a specific feature of online learning systems. The systems including hardware and software are usually updated or replaced. The interface design and system function significantly influence student motivation, attitude and achievement of online learning. Unstable online learning systems always cause frustration and anxiety with regard to online learning. As a result, it is necessary for students to understand the nature of Internet technology, application of a new system and approaches to handle it. In addition, online learners need to know how to solve problems or what resources (e.g. online assistant) they can ask for help when they encounter frustrations due to learning systems. Finally, positive attitude towards Internet technology is also required for successful online learning.

In summary, online learning environments challenge students with flexible time and space, indirect social interactions, abundant information resources and dynamic learning interfaces. Therefore, different learning strategies should be required for online learners to perform online learning effectively and efficiently.

Features of e-Learning Strategies

In-depth Interview

To understand online learning strategies adopted by students, an in-depth interview is performed based on the construct of strategic learning. Table 1 summarizes the interview framework.

Table 1. Interview frameworks and corresponding questions

Domain	Potential Elements	Explanation	Interview Questions
Skill	Comprehension	Strategies used to process online information and construct meaningful learning	When reading (or comprehending, or searching, or discussing) online teaching materials, what did you do to enhance your achievement and efficiency? Moreover, what did you do when you encountered problems?
	Internet Skill	Fundamental Internet skills required for online learning	How long have you been using the Internet? Moreover, what are the Internet skills that every e-learner should learn before taking an online course? What skills have you used in this course?
	Self-Awareness	Metacognitive knowledge possessed by individuals regarding themselves as online learners and regarding the nature of e-learning	In your opinion, is there any difference between e-learning and traditional learning? If yes, what are the differences? Moreover, what roles do students play in both curricula?
Will	Attitude	Attitudes towards the Internet and online learning	What do you like and dislike in such an online course? Why?
	Motivation	Motivation of online learning	Would you take such a course again in the future if given the opportunity? Why or why not?
Self-Regulation	Self-Monitoring	Self-monitoring strategies adopted to deal with the requirements of online courses	What approaches did you use to monitor, manage or regulate your online learning? For example, did you make plans for online learning? How did you control the plans you made?
	Concentration	Self-control strategies used to concentrate on e-learning	What approaches did you adopt to allow yourself to focus on your online learning?

In order to establish a strategic-learning interview framework, some potential elements are identified and initially categorized into the three domain strategies: skill, will and self-regulation. For example, the skill domain strategies involve the comprehension skills, Internet skills and self-awareness of online learners. Table 1 lists explanations and interview questions corresponding to each element.

Fourteen university senior students serve as subjects for the in-depth interview. The subjects were enrolled in a one-semester-long online course called “Computers and Education” conducted at a Taiwanese university. In this course, students were required to learn via the Internet individually and collaboratively with the exception of two face-to-face classroom meetings conducted for purposes of course introduction and evaluation. At the end of the semester, the subjects were interviewed according to the guidelines and questions listed in Table 1. All of the interviews were recorded and the transcripts were analyzed to examine or identify the elements of each domain strategies or even to identify specific e-learning domains. The concrete descriptions of the subject e-learning strategies were drawn out

and grouped under a related element and domain. The study data were also used as a key resource of the item pool of the instrument developed and described later in this study.

Elements of Online Learning Strategies

Based on the results of the in-depth interviews, three domain strategies specifically related to e-learning were identified to produce the *perceived-skill*, *affection* and *self-regulation* domains. All domains and elements with corresponding descriptions and examples of students' responses in the in-depth interview are summarized in Table 2.

Table 2. Domain strategies and corresponding elements identified from in-depth interview

Domain	Elements	Descriptions	Examples of Interview Results
Perceived-Skill	Comprehension	Constructing meaningful learning in an online learning environment is more complex than in a traditional learning environment. Specifically, achieving this requires high levels of cognitive abilities to process the information provided in an open-ended learning system such as the Internet. Many metacognitive skills are implicit and difficult to detect for online learners.	Sometimes I just don't understand what is displayed on screens in an online course. I try to catch the key points by taking notes for online learning. I watched the online course videos again and again. I look through titles or links before clicking any link for details.
	Internet Skill	Fundamental Internet skills required for online learning. This includes online search skills, online discussion skills, Internet file transfer skills, and so on. These skills are basic requirements for successfully undertaking online learning and the learners can easily be aware of these skills.	Online learners need to know how to control the system. One should learn how to use computers and Internet before online learning. When I cannot talk clearly in texts on MSN, I use Internet phone (e.g. skype) for online discussion.
	Self-Awareness	Metacognitive knowledge about self as online learners and about the nature of e-learning may be related to online learning experiences. Such knowledge is difficult for novice online learners to figure out by themselves particularly knowledge regarding their obligations and responsibilities. And this is rarely happened in a traditional learning environment.	Online learning is active learning. We should spend more time on searching for information. Online learning is free in location. We don't have to come to school campus. It is convenient for students who live far from schools. I am not clear about the teacher's requirements for this online course.
Affection	Attitude	Student attitudes towards the Internet and online learning are intimately related. Student perceptions of the Internet play a role in their willingness to use it for learning. Learning attitude in traditional learning environments is not such heavily dependent on a particular media as the Internet.	I think online learning is fancy. I don't like online learning, because I cannot ask teachers for questions. I don't like online learning because I don't like type. I think online learning can help me learn more than traditional learning.
	Motivation	Motivation for online learning may be more varied and complex than that for traditional learning. Moreover, locus of control in online learning environments	Since I am curious about online learning, I focus well on the course. I take this online course because I

		may differ significantly to that in traditional environments.	like computers. I feel online learning is fun.
	Anxiety	Anxiety of online learning is also related to student Internet using experience and online learning experience. The updating or changing characteristics of e-learning systems may create pressure in relation to online learning.	I worry about my computer skills for online learning. Online learning brings me pressure. I am afraid of online learning. I worry about how to communicate with others in online learning.
	Self-Monitoring	Monitoring the process of an online learning task requires a full understanding of associated subtasks and related resources so that learners can set proper goals and self-monitor their progress towards those goals. Students holding lower self-monitoring skills are more likely to have online disorientation problems. This is also a challenge for novice learners.	I always notice the latest news of the online course. I link to the discussion board everyday in order to update the progress of our group discussion. I speed up my online studying when I think it is almost delayed in progress.
Self-Regulation	Time Management	Online learning is more self-directed than traditional learning. Without many social scaffoldings or supports from teachers and peers, students require active time management skills for effective and efficient online learning.	I follow teachers' course schedule for online learning. I turn in my online homework in time. I randomly link to the online course website without any schedule.
	Concentration	The abundance of multimedia interactions provided in Internet environments distracts online learners from their learning more than in traditional environments. The cognitive load on novice online learners thus is increased. Online learners are required to be acquainted with skills to prevent themselves from numerous attractions of online multimedia or entertainment.	Online games and MSN distract me from online learning. Once I login to an online course website, I will not logout it before I finish a learning unit. When I login the online course, I open one window at a time. I often login to the online website in a quiet environment.

First, the *skill* domain is modified to become the *perceived-skill* domain because limited concrete descriptions or examples regarding comprehension and self-awareness can be drawn from their transcript data. This difficulty of detecting the implicit metacognitive skills of individuals may be more significant in e-learning environments due to the cognitive overloading to process online information. Second, since anxiety toward e-learning is strongly displayed in novice Internet users and novice online learners, an *anxiety* element has been included in the *will* domain. Therefore, the *will* domain has been replaced by the *affection* domain for a broader definition. Finally, *time management* element is drawn from *self-monitoring* in the self-regulation domain. This study suggests that these three identified domains and their relevant elements can be actively utilized by students to interact with the e-learning environment. Therefore, the three revised domains and corresponding elements have been all considered as key components to construct the model.

The Model

Based on the above analysis of e-learning environments and the in-depth interviews regarding student e-learning strategies, the Model of Strategic e-Learning is conceptualized in Figure 1. First of all, the definition of e-learning in this model indicates the activities and processes through individuals acquire knowledge, skill and attitudes by using

various digital tools. It is also referred to as Internet-based learning or online learning in this study. Under this broad definition, examples of e-learning include discussing homework with peers via email, searching for information on the Internet, reading online articles, participating in online discussions, and taking distance online courses.

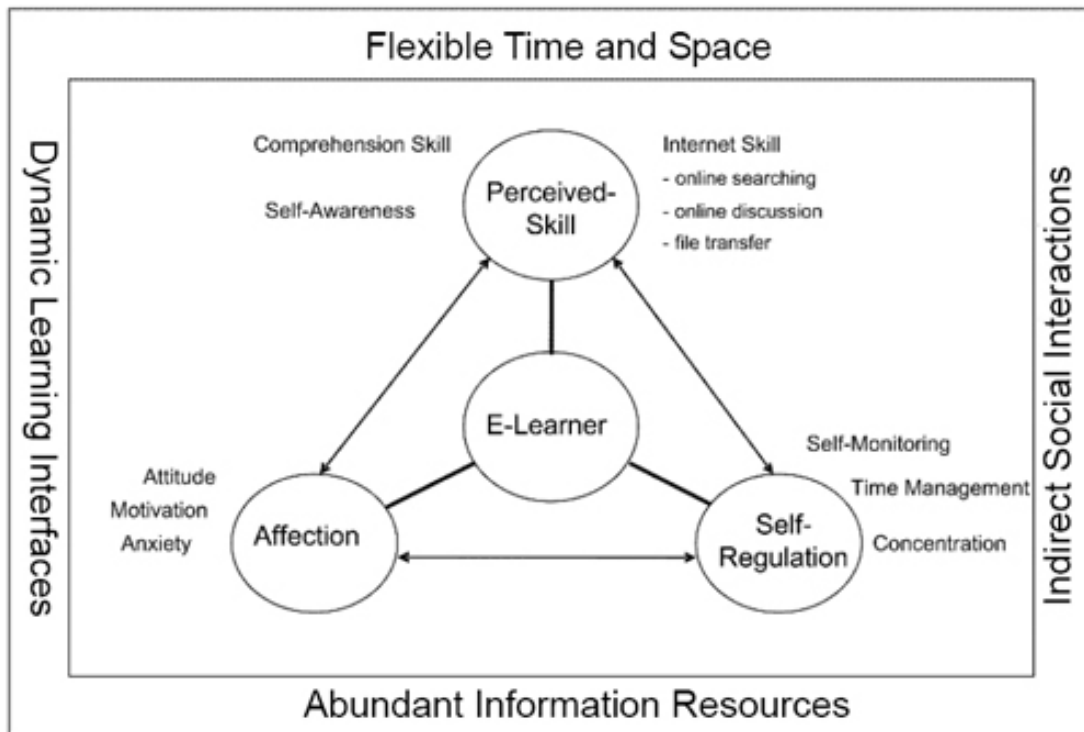


Figure 1. The Model of Strategic e-Learning

Secondly, the rectangle (in Figure 1) represents an e-learning environment and its four sides represent its four features: *flexible time and space*, *indirect social interactions*, *abundant information resources* and *dynamic learning interfaces*. There are four nodes within the rectangle in this model. The central node represents individual e-learners. Meanwhile, the three surrounding nodes represent the three domains of e-learning strategies which have been identified in the above student in-depth interviews. Thirdly, since individual e-learners can actively control these domain strategies to interact with the e-learning environment, there are three edges linking the central node (meaning the learner) with the three other nodes (meaning *perceived-skill*, *affection* and *self-regulation* domain strategies). The corresponding elements within the three domain strategies are listed aside the three nodes. Finally, bi-directional arrows exist between each pair of nodes, indicating the existence of interactions among the three domain strategies. For example, an individual with higher Internet self-efficacy may have better online search strategies, and a better time management strategy may be related to a better attitude toward e-learning.

In brief, this model can be used to profile how students interact with the complex e-learning environments when they are involved with Internet-based learning. In order to further investigate and modify this model in the future, this study developed an instrument for examining student e-learning strategies. The details are presented in the following section.

Online Learning Strategies Scale (OLSS)

Based on the above model, this study developed the Online Learning Strategies Scale (OLSS) as a research instrument to examine student e-learning strategies and provide feedback for modifying the model. The proposed instrument was developed in two stages: a pilot study and a main study. The pilot study involved the collection of a pool of candidate items for this instrument and obtaining preliminary testing statistics. The main study further modified the scale based on the results of a pilot study and further investigates its validity and reliability.

Pilot Study

In order to create a pool of candidate items of OLSS, content analysis was conducted to analyze the transcript data of the in-depth interviews. All clear descriptions and concrete statements regarding student behavioral skills, cognitive skills, metacognitive skills and knowledge, and affective responses reflected or used in online courses in relation to various interview questions are selected as candidate items. Finally, 36 statements were identified as candidate items for the OLSS instrument. Each statement was designed to be measured with a 5-point Likert scale ranging from 1 (not like me at all) to 5 (very much like me).

A survey (Tsai, 2007) involving the 36 items was administered to 136 senior high school students who participated in a six-week Internet-based learning activity as part of their required “Earth Science” course. A total of 118 valid questionnaires were collected. Factor analysis was used to examine structural validity. Furthermore, reliability analysis was used to assess internal consistency. Finally, a total of 22 items were included for further modification and development, and were grouped into the following seven subscales: *anxiety*, *attitude*, *time management*, *study aides*, *self-awareness*, *Internet literacy*, and *concentration*. Although these items explained 73.15% of the total variance, their reliabilities ranged from 0.53 to 0.85 for subscales. Table 3 illustrates the item numbers and subscale sample items for the initial version of the OLSS.

Table 3. The initial version of OLSS (Tsai, 2007)

Subscale	Reliability	Items	Sample Item
1. Anxiety	0.84	4	Online learning makes me very nervous.
2. Attitude	0.85	4	I think online learning is now important for students.
3. Time Management	0.80	3	I finish my online homework before the deadline.
4. Study Aides	0.75	3	I take online notes using word processors or graphic tools.
5. Self-Awareness	0.71	4	I understand the responsibilities of online learners.
6. Internet Literacy	0.78	2	I can search for information via the Internet.
7. Concentration	0.53	2	I am easily distracted from online learning by music or MSN.
Total	0.82	22	

Several suggestions (Tsai, 2007) were made based on the pilot survey results as follows: (1) modify or replace items #32 (*I am always late in submitting my online homework*) and #27 (*I am easily distracted from online learning by music or MSN*) to improve the low reliability ($\alpha=0.53$) of the *concentration* subscale; (2) replace and move item #7 (*I am able to participate in online discussions*) from the *self-awareness* subscale to the *Internet literacy* subscale for further clarification; (3) include more items regarding intrinsic motivation and self-monitoring in the pool; and (4) improve the balance of the item numbers across subscales. Finally, it is necessary to reexamine the validity and reliabilities after modifying the initial OLSS.

Main Study

Based on the above suggestions for further study, the 22 items extracted from the pilot study are modified as follows. Item #32 has been replaced and two new items have been added to the *concentration* subscale. Furthermore, item #7 has been moved from *self-awareness* subscale to *Internet self-efficacy* subscale (renamed the *Internet literacy* subscale) and a new item (*I am not sure about the teacher's expectation of my online learning*) is added to the *self-awareness* subscale. *Motivation* and *self-monitoring* subscales, each comprising four items, are added to the scale. Minor revisions are made to improve clarity and some new items are added to the *study aides* and *Internet self-efficacy* subscales to maintain balance across subscales. A revised version including 36 items classified under nine aspects thus is obtained and used for further examination. Again OR Additionally OR Furthermore, each item is measured using a 5-Likert scale ranging from 1(not at all like me) to 5(very much like me).

To validate the revised OLSS, another survey based on the revised 36 items was administered to 400 college students who had online learning experiences during the past three years and volunteered to answer the online survey. Because the survey was conducted on the Internet, extremely rigorous examination was used to discriminate invalid questionnaires. Therefore, only 261 questionnaires were left and used for data analyses in this investigation. A Principal Component factor analysis with Varimax rotation was used to examine the structural validity of the survey.

And a reliability analysis of Cronbach alpha was employed to assess its internal consistency. Table 4 lists the results of the rotated factor loadings and reliability analyses.

Table 4. Rotated factor loadings and Cronbach's α values for OLSS (20 items)

Item No	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
<i>Subscale 1 : Motivation ($\alpha=.86$)</i>					
13	.788				
22	.744				
29	.740				
35	.705				
7	.657				
<i>Subscale 2: Self-Monitoring ($\alpha=.67$)</i>					
17		.774			
18		.643			
14		.629			
3		.535			
<i>Subscale 3 : Internet Literacy ($\alpha=.67$)</i>					
5			.787		
20			.703		
11			.625		
32			.535		
<i>Subscale 4 : Internet Anxiety ($\alpha=.70$)</i>					
28				.798	
27				.749	
9				.696	
<i>Subscale 5 : Concentration ($\alpha=.70$)</i>					
12					-.794
21					.668
6					-.591
10					.528
Eigen Value	3.468	2.453	2.123	2.110	2.006
% of Variance	17.340	12.264	10.613	10.550	10.032
Total Reliability $\alpha=0.86$; Total variance explained is 60.80 % (N=261)					

Table 4 clearly reveals that five factors are extracted from the factor analysis, and these factors are then termed *motivation*, *self-monitoring*, *Internet literacy*, *Internet anxiety* and *concentration* subscales, including 5, 4, 4, 3, and 4 items, respectively. The final version of the OLSS thus contains a total of 20 items with a total explained variance of 60.80%. The reliability alpha is 0.86 for the total scale and ranges from .67 to .86 for all subscales. This means that the final OLSS has better internal consistency than the initial version of OLSS (0.82 for the total and from .53 to .85 for the subscales). Additionally, the numbers of items are more balanced across the subscales in the final version of the OLSS. Although the total explained variance (60.80%) is lower than for the initial version (73.15%), it still exceeds the level of acceptability (> 60%). All 20 items of the final version of OLSS are shown in Table 5. Each item is measured by a 5-Likert scale ranging from 1 (not at all like me) to 5 (very much like me), and thus the total score should range from 20 to 100. Items 6, 9, 12, 26 and 28 should be scored in reverse.

To summarize, the final version of the OLSS successfully modifies the initial OLSS. It not only draws out the motivation and self-monitoring components which are important but do not appear in the initial version but also increases the reliability of the concentration subscale from 0.53 to 0.70. In addition, the final version further clarifies the Internet literacy subscale and improves the balance of the item numbers across subscales. Although some subscales in the initial version do not appear in the final version, some of the items belonging to those subscales are categorized meaningfully in another related subscale. For example, item #10 is still included in the final version but shifts from the time management subscale to the concentration subscale. This phenomenon may occur because the

items of time management subscale in the initial OLSS may not have sufficient loading for an independent factor in the final OLSS. Item #10 holding stronger relationship with the concentration subscale than with the initial time management subscale is thus combined into the concentration subscale simultaneously with the time management subscale disappearing from the final version. Actually, both time management and concentration belong to the self-regulation domain in the model; therefore, it is not surprising to find that item #10 shifts from the time management to the concentration subscale. Besides the time management subscale, the attitude, study aids and self-awareness subscales in the initial version all display similar situations in the final OLSS. Therefore, the reduced number of subscales in the final version is reasonable and acceptable.

Table 5. The final version of OLSS (20 items)

Item no ^a	Subscale	Question
13	Motivation	I am attracted to online learning
22	Motivation	I am excited about learning on the Internet
29	Motivation	I like online learning
35	Motivation	I think online learning is convenient
7	Motivation	I am curious about online learning
17	Self-Monitoring	I make study plans for online learning
18	Self-Monitoring	I am able to use online learning aids
14	Self-Monitoring	I change my online learning plans as necessary
3	Self-Monitoring	I am able to take online notes using word processors or graphics tools
5	Internet Literacy	I am able to send and receive emails
20	Internet Literacy	I am able to search for information on the Internet
11	Internet Literacy	I understand the differences between online learning and traditional learning
32	Internet Literacy	I am able to download files from the Internet
28*	Internet Anxiety	Online learning system always make me feel frustrated
27*	Internet Anxiety	I do not have a good understanding of my progress in online learning
9*	Internet Anxiety	I am worried about my achievements in online learning
12*	Concentration	I am easily distracted from online learning by music or MSN
21	Concentration	I avoid anything that could interrupt my online learning
6*	Concentration	I cannot focus on my online learning
10	Concentration	I make good use of my time for online learning

Note. ^a The item number indicates the item order in the second pool of candidate items (a total of 36 items).

* Reversed scoring items: 6, 9, 12, 27, 28

Students' OLSS Scores

The main study further investigated students' OLSS scores and their background information. Table 6 summarized the mean scores, item numbers and average scores for each item in subscales of OLSS. Each average score is calculated by dividing the mean by the item number for each subscale. The average scores range from 3.17 to 4.36 in a 5-likert rating scale. This indicates that in average these online learners hold above medium levels of online learning strategies. The above medium scores are reasonable since the subjects of the main survey were selected from those who had online learning experience. In addition, the score of Internet Literacy (4.36) is significantly higher than the total average score (3.66) and the score of Concentration (3.17) is quite lower than the total average score. This suggests that the online learners possess good Internet literacy skills but only have fair concentration strategies for online learning. And this result is not surprising when further examining the subjects' weekly online hours for general purposes and weekly online hours for learning purpose. The former is 31.43 hours and the later is only 3.2 hours in average. Furthermore, in average, the 261 subjects were 23.08 years old with 7.96 years of Internet using experience and had taken 1.4 online courses.

In addition, this study also explored if there was any significant difference in OLSS scores between male and female students. Table 7 summarized results of the ANOVAs of the OLSS scores between genders. There were 130 males and 131 females in the 261 online learners. The results showed that there was not any significant difference between male and female students' online learning strategies in all dimensions. This means that both male and female online learners had about the same levels of online learning strategies. However, one thing should be noticed again is that

these subject were not randomly selected for this study, therefore, further investigations regarding gender differences in online learning strategies are still needed in order to draw a conclusion.

Table 6: The average item score of OLSS subscales

OLSS	Mean	Item	Average
Motivation	18.56	5	3.71
Self-Monitoring	13.79	4	3.45
Internet Literacy	17.45	4	4.36
Internet Anxiety	10.66	3	3.55
Concentration	12.67	4	3.17
Total	73.13	20	3.66

Note. N=261

Table 7: The ANOVAs of OLSS scores between male and female students

OLSS		N	Mean	SD	p
Motivation	Male	130	18.50	3.45	.793
	Female	131	18.61	3.36	
Self-Monitoring	Male	130	13.95	2.72	.293
	Female	131	13.61	2.47	
Internet Literacy	Male	130	17.45	1.65	.958
	Female	131	17.46	1.94	
Internet Anxiety	Male	130	16.63	2.27	.821
	Female	131	16.69	2.28	
Concentration	Male	130	12.55	2.91	.501
	Female	131	12.79	3.02	
Total	Male	130	72.74	9.59	.498
	Female	131	73.51	8.81	

Conclusions

This study proposed the Model of Strategic e-Learning to explain student online learning from metacognitive perspectives. The model identifies four characteristics of online learning environments, namely: *flexible time and space, indirect social interactions, abundant information resources and dynamic learning interfaces*. Three domains of e-learning strategies are identified in the mode, namely the *perceived-skill, affection and self-regulation* domains. Potential elements and corresponding features in each domain strategy are also illustrated and elaborated in this work. *Self-regulation* domain is especially important and appropriate for online learners (McManus, 2000), because they need considerable enormous control over their time schedule, and how they approach online learning.

Based on the above model, the Online Learning Strategies Scale (OLSS) is developed as an instrument to evaluate student online learning strategies. The final version of the OLSS is composed of 20 items categorized under five subscales as follows: *motivation, self-monitoring, Internet literacy, Internet anxiety and concentration* subscales, all of which have good reliability. The *motivation* and *Internet anxiety* subscales investigate student *affection* domain strategies, while the *Internet literacy* subscale assesses *perceived-skill* domain strategies, and the *self-monitoring* and *concentration* subscales examine *self-regulation* domain strategies. Some may argue that self-reporting scale is inappropriate for measuring individual metacognition, especially for skills and self-regulation; however, it is possible to identify various cognitive and motivational profiles related to student behavior (Pintrich et al., 1991).

Discussions

The Model of Strategic e-Learning provides a framework for systematically analyzing student online learning strategies. The interfaces of online learning systems are rapidly changing and continuously developing. How online learners handle their own learning and the approaches they use to interact with specific learning systems are

important issues in evaluating the impact of specific e-learning systems on student online learning. The proposed model provides a general scope for understanding and analyzing student online learning and learning strategies. Furthermore, the Online Learning Strategies Scale (OLSS) can be used to examine student online learning strategies. OLSS provides e-learning researchers, system designers, curriculum developers, instructors and even learners themselves with a diagnostic instrument for understanding the advantages and disadvantages of online learning for students, as well as e-learning researchers, system designers and online curriculum developers. OLSS scores can provide feedbacks for e-learning system designers, curriculum developers and instructors before or after they design or develop systems or curriculum. These scores can even serve as feedback that can help online students to obtain greater self-awareness of their own online learning.

Based on the Model of Strategic e-Learning, the study developed the OLSS for evaluating students' e-learning strategies. However, in this current stage, the OLSS may not fully describe the proposed model and the model may need to be further modified based on repeated surveys. For example, the domain of perceived-skill strategies, especially the comprehension strategies was omitted largely from the final version of OLSS. This may be due to the comprehend strategies, not like the Internet skills, are too implicit to be self-detected by learners themselves. Or it could suggest that the comprehension strategies dealing with comprehension monitoring may be closer to self-regulation domain than perceived-skill domain. Therefore, further examinations by OLSS and modifications of the model are needed in the future.

Future studies should also explore the relationships between student online learning strategies and their online learning achievements. In addition, it is important to examine the role played by individual differences in student online learning strategies, for example, the influences of the epistemological views of students, or the relationships of those views with online learning strategies. Finally, the learning strategies included in OLSS are general online learning strategies, and effective learning strategies may be discipline specific. Therefore, further research is required to investigate the appropriateness of the proposed instrument for various online learning activities such as online searching and online discussion.

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