Self-Efficacy for Self-Regulated Learning, Academic Self-Efficacy, and Internet Self-Efficacy in Web-Based Instruction

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Effects of student motivation on performance in Web-based instruction (WBI) were examined. In particular, applicability of the self-efficacy theory to WBI contexts was tested. A total of 152 junior high school students in Seoul, Korea, participated in WBI during regular science classes. Participants completed motivational surveys before the onset of WBI and took the written and search tests at the end of WBI. Path analyses revealed that students' self-efficacy for self-regulated learning positively related to their academic self-efficacy, strategy use, and Internet self-efficacy. Academic self-efficacy predicted students' performance on the written test, which comprised problems on topics covered during the previous WBI sessions. Students' scores on the WBI search test were significantly and positively predicted by their self-efficacy in using the Internet. More interesting, students' academic self-efficacy beliefs were not able to predict their search test performance, whereas students' Internet self-efficacy beliefs were not able to predict their written test performance.

□ One branch of computer-based instruction (CBI) that has become increasingly popular in recent years is Web-based instruction (WBI). While providing valuable and arguably most powerful resources to education (Fetterman, 1998), WBI, or CBI in general, puts an increasingly heavier burden on individual learners' motivation and capability to be responsible for their own learning processes and outcomes (Owston, 1997; Santiago & Okey, 1992). The present investigation examined relationships among several motivation and learning-related variables in Web-based learning. In particular, it focused on the effects of various self-efficacy perceptions on learning outcomes of WBI.

SELF-EFFICACY IN ACADEMIC LEARNING

Academic self-efficacy refers to one's convictions to perform successfully at designated levels (Schunk, 1991). Ample evidence accrued during the past two decades demonstrates the strong and positive influence of efficacy beliefs on various aspects of student motivation and achievement (e.g., Bandura & Schunk, 1981; Betz & Hackett, 1981; Pajares & Miller, 1994; Pintrich & De Groot, 1990; Schunk, 1982, 1983, 1984; Zimmerman, Bandura, & Martinez-Pons, 1992; see also Pajares, 1996, for a review and Multon, Brown, & Lent, 1991, for a meta-analysis). Schunk's (e.g., 1982, 1983, 1984) series of experiments, for example, documented that as students' self-efficacy perceptions strengthened,

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their performance also noticeably improved. Pintrich and De Groot (1990) reported that academic self-efficacy beliefs positively related to intrinsic value and cognitive and self-regulatory strategy use, and negatively correlated with test anxiety. Self-efficacy also positively correlated to various outcome measures such as grades, seatwork performances, scores on exams and quizzes, and quality of essays and reports.

Not only does academic self-efficacy influence learning and performance, self-efficacy for self-regulated learning also relates to performance through its direct link to academic self-efficacy and goal setting. Self-efficacy for self-regulated learning refers to students' perceived capability to use a variety of self-regulated learning strategies such as self-monitoring, self-evaluation, goal setting and planning, self-consequences, and environmental restructuring (Zimmerman et al., 1992; Zimmerman & Martinez-Pons, 1988). Zimmerman et al. observed that self-efficacy for self-regulated learning positively related to self-efficacy for academic achievement, which in turn positively linked to students' grade goals and final grades. Likewise, Zimmerman and Bandura (1994) reported that self-regulatory efficacy for writing positively related to self-evaluative standards and self-efficacy for academic achievement, both of which demonstrated positive relations with grade goals students set for themselves in a college writing course. The latter three variables predicted students' final course grades.

SELF-EFFICACY IN COMPUTER-BASED INSTRUCTION

One might wonder whether the strong and positive effects of self-efficacy beliefs evidenced in typical classroom research would hold in computer-integrated learning environments. Evidence is not conclusive but there is an indication that it might be the case. Hill and Hannafin (1997) studied the influence of perceived orientation, perceived self-efficacy, system knowledge, and prior subject knowledge on strategies employed in a World Wide Web (WWW) search. Participants' self-efficacy beliefs, or their confidence in using computer technologies in general and in searching through electronic information systems, affected both the number and types of strategies they used in the search. Those with stronger self-efficacy explored the system more vigorously, whereas those who lacked such confidence retreated and concentrated on simply locating information. Al-Khaldi and Al-Jabri (1998) reported that confidence in using computers was also a significant positive predictor both of frequency and intensity of computer use and of diversity of software packages used. Levine and Donitsa-Schmidt (1998) found that as subjects expressed stronger computer confidence, they also demonstrated more positive attitudes toward computers and higher levels of computer-related knowledge. Prior experience with computers predicted strength of computer confidence subjects expressed.

THE PRESENT INVESTIGATION

Self-efficacy research in CBI contexts mainly concerned learners' confidence in using computers. However, the role of motivational variables such as self-efficacy in CBI seems to be more complicated than has been previously assumed. In a typical CBI or WBI setting, computer self-efficacy is often one of the major and most conspicuous factors determining the success of one's performance (see, e.g., Hill & Hannafin, 1997). Nevertheless, learners still need to digest the materials they acquire from successful maneuvering in the system. Perceived self-efficacy in successful mastery of the given academic material is therefore as, if not more, important as perceived efficacy in skillful manipulation of the information technologies.

Self-efficacy researchers emphasized that self-efficacy beliefs should be assessed in such a way that the beliefs correspond to the target performance and domains of interest. To test this idea, Pajares and Miller (1995) assessed students' self-efficacy beliefs for (a) solving specific math problems, (b) completing everyday math tasks, and (c) performing in math-related courses. These three types of self-efficacy beliefs were related to two outcome measures: (a) math problem-solving performance and (b) choice of math-related majors. Although all self-efficacy and outcome measures were positively correlated, math problem-solving performance was best predicted by problem-specific self-efficacy, whereas choice of math-related majors was best predicted by course-specific self-efficacy. Assuming that both computer-specific and content-specific self-efficacy beliefs play a crucial role in WBI, Pajares and Miller's finding attests to the need to examine their independent contributions to a given outcome.

Surely, we would not expect all learners with the same level of computer self-efficacy to demonstrate the same level of academic self-efficacy or vice versa. One type of self-efficacy may emerge with greater predictive usefulness than the other, depending on the nature of criterial tasks. In the present study, students' perceived self-efficacy for the use of the Internet and for academic learning in the given subject matter (i.e., biology) were separately assessed. These two forms of self-efficacy beliefs were linked to performance measures obtained at the end of the WBI unit. One of the performance measures was a written test on the materials covered during the WBI lessons, which did not require any Internet connection or computer use. The other was a search test in which students had to connect to specific Internet sites and search for necessary information before being able to answer the questions. On the basis of Pajares and Miller's (1995) finding, academic self-efficacy was hypothesized to show a stronger relationship to the written test performance, whereas Internet self-efficacy was hypothesized to relate more strongly to the search test performance.

The role of self-efficacy for self-regulated learning in WBI was also explored. Compared with traditional didactic instruction where learners expect most of the necessary information to be conveyed by the instructor in an orderly fashion, CBI, particularly WBI, expects learners to take more initiatives in actively seeking and sifting through available information. Young (1996), for example, found that learners with superior self-regulatory capabilities performed better in learner-controlled CBI than in program-controlled instruction. However, those with poor self-regulatory capabilities were at considerable disadvantage in learner-controlled CBI, which permitted and even required substantial control from the learners over the pace and content of their learning. In the present research, self-efficacy for self-regulated learning was predicted to relate positively to the two performance outcomes through its direct links to academic and Internet self-efficacy.

Self-efficacy beliefs exert their effects on performance directly as well as indirectly through various cognitive and affective mechanisms. Strategy use was one of the variables believed to mediate relations between perceived capability and actual performance. For example, Horn, Bruning, Schraw, Curry, and Katkanan (1993) reported that students with a stronger sense of self-efficacy tended to use more strategies, which eventually resulted in better classroom performance. In the present context, students reported their use of a variety of cognitive and self-regulatory strategies. Because self-regulatory capabilities take on increasingly greater importance in CBI, we hypothesized that self-regulatory strategy use, along with cognitive strategy use, would emerge as a significant positive mediator between self-efficacy beliefs and performance in WBI.

Finally, important background variables such as gender, prior academic achievement, and previous experience with computers were incorporated. As Bandura (1977, 1997) suggested, previous personal experience with the given task is often the strongest predictor of one's percept of efficacy. In the current investigation, students' standardized achievement test scores in science were used as a measure of prior academic achievement because the WBI dealt with biology topics. Likewise, students' prior experience with computers was included because it is the most salient predictor of computer-related confidence and attitudes (Levine & Donitsa-Schmidt, 1998). Also of moderate interest were effects of gender. Previous research on self-regulated learning documented significant gender differences favoring girls (Zimmerman & Martinez-Pons, 1990). On the other hand, boys tend to spend more time with computers and technologies in general and to display more positive attitudes towards them (Chen, 1986; Joo, Lee, & Bong, 1998). The present research examined the effects of gender in WBI contexts.

METHOD

Participants and Procedures

Participants were 152 sophomores in a coed junior high school (i.e., roughly equivalent to United States Grade 8) in Seoul, Korea. The school from which participants were recruited was designated as one of the leading schools for promoting information literacy by the Korean Ministry of Education in 1998. The sample consisted of 112 males (74%) and 40 females (26%). Approximately 95% of the participants reported having previous experience working with computers; of those, 20% reported having used computers for more than three years at the time of the survey.

A week before the onset of the WBI, students responded to a questionnaire asking about their self-efficacy for self-regulated learning, academic self-efficacy, and strategy use. Students' Internet self-efficacy was assessed at the beginning of the second WBI session. The three WBI sessions were conducted according to lesson plans developed by the third author and approved by the school biology teacher. Students took written and search tests during the fifth week of research.

Measures

Background information. Students' grade level, gender, and previous experience using computers were asked. Gender was coded as 1 (*male*) and 2 (*female*). The prior computer experience item read "How long have you been using computers?" A response scale ranged from 1 to 4 with the following verbal descriptors: 1 (*less than a year*), 2 (*more than a year but less than 3 years*), 3 (*more than 3 years but less than 6 years*), and 4 (*more than 6 years*).

Prior science achievement. Students' scores on the standardized science achievement test were obtained from the school record. The test was grade specific and was one of the five subject tests (i.e., Korean, English, mathematics, social studies, and science) administered by the Korean Institute of Curriculum and Evaluation (KICE) and supervised by the Seoul Office of Education. The science test was composed of 30 questions, of which 20 were multiple-choice (3 points each) and 10 were short-answer (4 points each). The total score could thus range between 0 and 100. Students were given 45 min. to complete the test. Because the WBI dealt with biology topics and was conducted during science classes, scores on this nation-wide exam were used as a measure of prior science achievement.

Self-efficacy for self-regulated learning. All 11 items used by Zimmerman et al. (1992) were adopted. Sample items read: "I can finish homework assignments by deadlines," "I can study when there are other interesting things to do," "I can concentrate during class," and "I can arrange a place where I can study without distractions." When items were being translated into Korean, negatively phrased items and those phrased as questions were rephrased as positive statements for consistency without changing the original meaning. Two experts in related fields of educational technology were consulted to verify the validity of translated items. The items were subsequently shown to a junior high school teacher who checked the appropriateness of vocabulary for junior high school students. The same procedures applied to all scales used in this research. Scores on this Self-Efficacy for Self-Regulated Learning scale have shown significant positive correlations with more specific forms of self-efficacy beliefs ranging from self-efficacy for solving specific problems to self-efficacy for academic achievement (Bong, 1999; Zimmerman et al., 1992). A response scale ranged from 1 (*not at all true*) to 5 (*very true*). The Cronbach's α reliability coefficient was .82.

Academic self-efficacy. The Self-Efficacy subscale of the Motivated Strategies for Learning Questionnaire (MSLQ) were used. Previous research shows that scores on this scale significantly and positively related various learning outcomes (e.g., Bong, 1997, Pintrich & De Groot, 1990). Several items on the original MSLQ solicit comparative assessment of one's perceived competence within a given domain. However, self-efficacy is more heavily influenced by one's prior mastery experiences than by normative comparison (Bong & Clark, in press; Zimmerman, 1995). Items on the MSLQ that prompt explicit social comparison (e.g., "Compared with other students in this class,") were thus deleted or rephrased. One item was dropped from the 9-item scale because it was considered redundant. Because the WBI introduced biology topics, all 8 items referred to students' academic confidence in biology. Sample items were as follows: "I'm certain I can understand what is taught in biology," and "I believe I can do an excellent job on the problems and tasks assigned for this biology class." A response scale ranged from 1 (*not at all true*) to 5 (*very true*). The Cronbach's α for this scale was .90.

Internet self-efficacy. Perceived capability to use the Internet was assessed by 13 items (see Appendix A). Items were first selected from two published studies on the basis of their importance and relevance to WBI contexts: 3 were adapted from the Computer Self-Efficacy (CSE) scale developed by Murphy, Coover, and Owen (1989); another 4 were adapted from the CD-ROM self-efficacy items published in Ertmer, Evenbeck, Cennamo, and Lehman (1994). The word *CD-ROM* in each of these items was replaced with *Internet*. Although the 7 items so selected addressed some aspects of WBI, they were deemed insufficient to incorporate all major skills required in WBI. The self-efficacy theory prescribes that self-efficacy assessment should be able to reflect different facets of the activity domain, types of capabilities required, and situational circumstances in which those capabilities are exercised (Bandura, 1997). Therefore, 6 additional items were developed to incorporate essential skills in WBI that had not been addressed yet. A response scale ranged from 1 (*not at all true*) to 5 (*very true*). Although validity of this particular 13-item scale remains to be seen, scores on the scale exhibited high internal consistency as demonstrated by the Cronbach's α of .95.

Strategy use. The Cognitive Strategy Use and Self-Regulation subscales of the MSLQ were used. There were 13 items for the Cognitive Strategy Use and 9 items for the Self-Regulation scales. Sample items for Cognitive Strategy Use were: "When I study for a test, I try to put together the information from class and from the book," and "When I study, I put important ideas in my own words." Sample items for Self-Regulation were: "I ask myself questions to make sure I know the material I have been studying," and "Before I begin studying, I think about the things I will need to do to learn." A response scale ranged from 1 (*not at all true*) to 5 (*very true*). Pintrich and De Groot (1990) reported that scores on the Cognitive Strategy Use scale correlated .18 to .20 with average grades and exam scores, and those on the Self-Regulation scale correlated .22 to .36 with the same measures. The Cronbach's α reliability coefficients from the current study were .86 and .77 for the Cognitive Strategy Use and Self-Regulation scales, respectively.

Performance measures. Two types of performance measure were obtained at the end of the WBI. One was a written exam composed of 20 questions, of which 17 were multiple-choice and 3 were short-answer. These items dealt with materials students had learned during the previous WBI sessions and did not require use of computers or connection to Internet sites. The other performance measure was a search test that required students to connect to two particular Internet sites in order for them to answer given questions. Students had to locate necessary information within the assigned Web sites. The search test dealt with related topics of "Parts and Functions of Animal Body." There were 20 questions on the search test (10 questions for each site), half of which were multiple-choice and the other half, short-answer. All of the written and search test items were developed in consultation with the school biology teacher. Each item was worth 5 points. Students were given 60 min. to complete both tests. The tests were designed as speed tests (in contrast to power tests) because we reasoned that effective use of strategies would result in most dramatic differences on such performances. Appendix B presents sample items for both the written and search tests.

Web-based instruction. There were three WBI sessions, conducted once a week for three weeks during regular science classes. All sessions were organized by the third author in cooperation with the school biology teacher. The first session introduced basic skills and strategies of Internet use because we did not want students' previous experience with computers or the Internet to be a determining factor of their Internet self-efficacy or their search performance. One of the main purposes of this session was to familiarize students with basic procedures required in WBI. Students were provided with instructions and exercises on how to use the Internet, while working on a biology topic called "Common Diseases for the Organs in Our Body." Although emphasis was placed on technical aspects of WBI, students performed the same activities as they would in other upcoming WBI sessions. During this session, the teacher announced to students that two WBI sessions would follow, both of which would cover topics from the same biology chapter, titled "Parts and Functions of Animal Body". He also announced that written and search tests would be administered at the completion of the WBI.

At the beginning of each WBI session, the biology teacher briefly reviewed prior learning, stated lesson objectives, and presented uniform resource locators (URLs) of helpful Web sites. Students were provided with worksheets that listed lesson topics and URLs at the top. The lesson topic for the second session was "Smoking and Health," and for the third lesson, "Drugs and Prevention." The worksheets were organized around important terms, facts, concepts, and principles in the form of questions and blank tables. Once students connected to a particular Web site, they needed to branch out and move back and forth within the site until they successfully located necessary information for filling out their worksheets. Students also located additional information on given topics from other Web sites by using commercial search engines and search words.

Each student worked independently in front of a computer across sessions. The classroom teacher and the third author monitored students' learning activities and answered questions both on the learning materials and the use of the Internet. When students completed their worksheets, the teacher briefly went over important contents of the lesson and introduced the next week's topic.

RESULTS

Preliminary Analyses

Table 1 presents descriptive statistics of scales. Because the school provided the investigators with only students' total scores on science achievement and WBI tests, reliability coefficients could not be estimated for these measures. Reliability was not estimated for previous experience working with computers because it was a single-item measure. Response scales for self-efficacy for self-regulated learning, academic self-efficacy, Internet self-efficacy, cognitive strategy use, and self-regulated strategy use ranged from 1 (*not at all true*) to 5 (*very true*). Scale averages are reported for these variables to aid cross-scale comparison. All scales demonstrated acceptable levels of reliability with the current sample (i.e., αs > .70). Sample sizes vary between 138 and 152 because of missing data.

A series of t tests was first conducted to determine whether there were any gender differences. Among motivational variables, a significant difference was detected on self-efficacy for self-regulated learning, $t(148) = -2.67$, $p < .01$ ($\bar{X}$s = 2.98 for males and 3.23 for females), and cognitive strategy use, $t(148) = -3.35$, $p < .001$ ($\bar{X}$s = 3.13 for males and 3.48 for females), both favoring females. Female superiority in self-regulated learning and cognitive strategy use has been documented in previous research (Pokay & Blumenfeld, 1990; Zimmerman & Martinez-Pons, 1990). Females also outperformed males on the written exam based on the WBI contents, $t(114.70) = -4.15$, $p < .001$ ($\bar{X}$s = 61.16 for males and 73.00 for females). In contrast, males reported having used computers for longer periods compared to females, $t(136) = 2.09$, $p < .05$ ($\bar{X}$s = 1.98 for males and 1.65 for females). The advantage in previous computer experience by males did not extend itself to stronger Internet self-efficacy. Although males expressed slightly higher Internet self-efficacy compared with females, the difference was not statistically significant, $t(150) = 1.45$, $p > .05$ ($\bar{X}$s =

3.41 for males and 3.16 for females). These results were not surprising because students' Internet self-efficacy was assessed after the first WBI session, which was conducted with a specific aim of acquainting the students with basic Internet search procedures.

Correlational Analyses

Zero-order correlations were computed to examine relations among variables. As Table 2 shows, scores on the standardized science achievement test correlated moderately highly with scores on the WBI written test (r = .495). The standardized achievement test scores also correlated moderately highly with self-efficacy for self-regulated learning (r = .408), academic self-efficacy (r = .458), self-regulation strategy use (r = .475), and scores on the WBI search test (r = .402). Students who received higher scores on the standardized science test were more confident about their academic learning in biology and self-regulation. Self-efficacy for self-regulated learning was in turn highly correlated with academic self-efficacy (r = .600) and cognitive and self-regulated strategy use (rs = .709 and .740, respectively). The two strategy-use variables were also highly correlated with each other (r = .735). Scores on the standardized science achievement test, self-efficacy for self-regulated learning, academic self-efficacy, self-regulation strategy use, and cognitive strategy use all significantly and positively correlated with scores on the WBI written test (rs ranging between .308 and .495).

Whereas variables of academic motivation and performance were significantly correlated among themselves, their relations with computer-related variables were noticeably weaker. Previous experience working with computers showed a significant correlation only with Internet self-efficacy (r = .396) and not with any other variables. Internet self-efficacy significantly correlated with other academic motivation and performance variables, but the magnitude of those relationships was not as strong as with academic self-efficacy. The only exception to this trend was the correlation between Internet self-efficacy and the WBI search-test scores. Compared

Table 1 ☐ Descriptive Statistics of Scales and Achievement Tests

	Males			Females			Total			
Scale	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*	α
Standardized Science Achievement Test	42.07	20.75	111	42.58	22.90	40	42.21	21.26	151	—
Previous Experience Working With Computers	1.98_a	.86	101	1.65_b	.72	37	1.89	.83	138	—
Self-Efficacy for Self-Regulated Learning	2.98_a	.54	110	3.23_b	.48	40	3.04	.54	150	.82
Academic Self-Efficacy	2.79	.62	110	2.90	.73	40	2.82	.65	150	.90
Internet Self-Efficacy	3.41	1.00	112	3.16	.82	40	3.34	.96	152	.95
Cognitive Strategy Use	3.13_a	.56	110	3.48_b	.55	40	3.22	.58	150	.86
Self-Regulated Strategy Use	2.83	.57	110	2.99	.50	40	2.87	.55	150	.77
WBI Written Test	61.16_a	21.28	112	73.00_b	12.80	40	64.28	20.06	152	—
WBI Search Test	83.17	20.09	112	82.00	17.79	40	82.86	19.46	152	—

NOTE: *Ns* vary because of missing data. Means with different subscripts differ significantly at $p < .05$ between gender. Response scales for self-efficacy for self-regulated learning, academic self-efficacy, Internet self-efficacy, cognitive strategy use, and self-regulated strategy use ranged from 1 (*not at all true*) to 5 (*very true*). Previous experience working with computers were answered with 1 (*less than a year*), 2 (*more than a year but less than three years*), 3 (*more than three years but less than six years*), and 4 (*more than six years*). Scores on the standardized science achievement test could range from 0 to 100. Scores on all self-efficacy and strategy use scales were averaged within each scale to range from 1 to 5. Scores on both the WBI written and search tests could range from 0 to 100.

with the WBI written test scores, which correlated higher with academic self-efficacy (r = .322) than with Internet self-efficacy (r = .247), scores on the WBI search test correlated higher with Internet self-efficacy (r = .364) than with academic self-efficacy (r = .266). The strong correlation of academic self-efficacy with written-test performance and that of Internet self-efficacy with search-test performance are consistent with the present study's a priori prediction.

Path Analyses

Path analytic techniques afford many advantages over both zero-order correlation and multiple regression analysis. The most significant advantage of path analysis over multiple regression may be its ability to allow researchers to specify and subsequently test models based on their theory and to partition direct and indirect effects of a given variable on its purported outcome variables (Pedhazur, 1982). In the present investigation, an a priori model was specified according to findings from previous research.

The a priori path model specified gender as an exogenous variable relating to prior science achievement, self-efficacy for self-regulated learning, and previous experience working with computers. Prior science achievement was hypothesized to predict self-efficacy for self-regulated learning. This path contrasts with findings from previous research where prior achievement (Zimmerman et al., 1992) or aptitude (Zimmerman & Bandura, 1994) did not significantly correlate with self-efficacy for self-regulated learning. Nevertheless, if we examine the a priori model of Zimmerman et al. (1992), we find that a significant positive relation was initially expected between students' prior grades and self-efficacy for self-regulated learning. In addition, correlational analysis reported above found a significant positive correlation between these two variables. Therefore, we decided to retain the path between prior science achievement and self-efficacy for self-regulated learning in our a priori model. Self-efficacy for self-regulated learning was also hypothesized to relate to the two strategy use variables.

Both prior science achievement and self-efficacy for self-regulated learning were hypothesized to relate positively to students' percepts of academic self-efficacy. Academic self-efficacy was in turn postulated to predict students' performance on the WBI written test directly as well as indirectly through strategy use. The path model thus incorporated the reciprocal relationship between self-efficacy and performance such that prior achievement alters subsequent self-efficacy, which then affects resultant perfor-

Table 2 ☐ Zero-Order Correlation Coefficients Among Variables

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1.Standardized Science Achievement Test	—								
2.Previous Experience Working With Computers	.195[1]	—							
3.Self-Efficacy for Self-Regulated Learning	.408[3]	.057	—						
4.Academic Self-Efficacy	.458[3]	.112	.600[3]	—					
5.Internet Self-Efficacy	.328[3]	.396[3]	.327[3]	.314[3]	—				
6.Cognitive Strategy Use	.332[3]	.059	.709[3]	.557[3]	.263[3]	—			
7.Self-Regulation Strategy Use	.475[3]	.060	.740[3]	.531[3]	.282[3]	.735[3]	—		
8.WBI Written Test	.495[3]	−.058	.325[3]	.322[3]	.247[2]	.308[3]	.320[3]	—	
9.WBI Search Test	.402[3]	.112	.210[2]	.266[3]	.364[3]	.269[3]	.249[2]	.437[3]	—

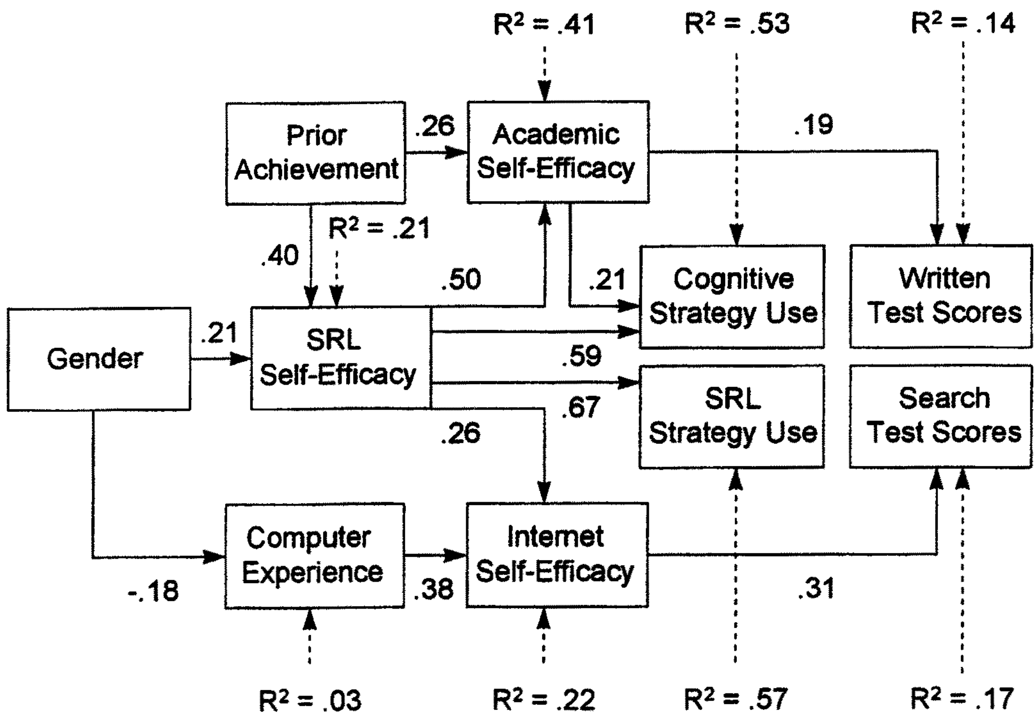
[1] $p < .05$. [2] $p < .01$. [3] $p < .001$.

mance. The WBI search test required learners to connect to and search through the designated Internet sites and hence included many unique components that are not commonly found in traditional didactic instruction. However, all WBI processes were conducted as part of regular science classes in which academic self-efficacy presumably plays a major role. In addition, it was of interest to determine whether the predictive usefulness of self-efficacy beliefs actually differed according to their correspondence to the criterial tasks (Bandura, 1997; Pajares, 1996). Therefore, performances on both the WBI written and search tests were hypothesized to be under the influence of both academic and Internet self-efficacy perceptions.

Previous experience with computers was hypothesized to predict students' Internet self-efficacy. Self-efficacy for self-regulated learning was also presumed to relate positively to Internet self-efficacy. This path was specified on the basis of the finding that self-regulated learning capability is critical for successful learning in CBI contexts (Young, 1996). For reasons described above, direct positive paths were prescribed between students' Internet self-efficacy and their performance on the WBI search as well as written tests. Cognitive and self-regulatory strategy use were also expected to predict the search performance.

Figure 1 presents results from the path analysis with R^2 values. Consistent with previous reports, gender (male = 1, female = 2) demonstrated a significant positive relationship (females > males) with self-efficacy for self-regulated learning ($\beta = .21$) and a significant negative relationship with previous computer experience ($\beta = -.18$). As hypothesized, prior science achievement ($\beta = .26$) and self-efficacy for self-regulated learning ($\beta = .50$) positively related to academic self-efficacy. The two variables accounted for roughly 41% of the variance in academic self-efficacy ($R^2 = .41$). Academic self-efficacy significantly and positively predicted students' reported cognitive strategy use ($\beta = .21$) and their WBI written-test performance ($\beta = .19$). Although academic self-efficacy was able to link directly to students' performance on the

Figure 1 ☐ Final path model. Only significant paths are shown ($p < .05$). Gender was coded 1 = male and 2 = female.



written test, magnitude of this effect was somewhat weak in light of previous findings. Indirect effect of self-efficacy on performance through strategy use was not evidenced. Neither cognitive nor self-regulation strategy use related significantly to students' WBI written- or search-test performance. This casts some doubt on the usefulness of self-reports of strategy use.

Limitations such as impression management and response sets of self-report or survey data are well-known (Cohen, Montague, Nathanson, & Swerdlik, 1988). Students who participated in the present study may have failed to make a clear distinction between scales or between items on each scale. The possibility that the high correlations of strategy use variables with other self-report measures were due to the shared method variance cannot be completely ruled out. However, Table 2 shows that the reported use of both cognitive (r = .332) and self-regulation (r = .475) strategies significantly and positively correlated with students' scores on the standardized science achievement test. Another plausible explanation for the nonsignificant link between the strategy use and performance in the present research can be found in the way the items were phrased. Compared with academic self-efficacy items that specifically referred to the biology class, items on both the cognitive and self-regulation strategy-use scales referred to general classroom situations. Because these items did not refer to the particular class in which the WBI was being conducted, students' responses may not have reflected accurately how they actually behave in biology classes or study for biology exams.

Previous experience working with computers significantly and substantially related to perceptions of self-efficacy toward using the Internet (β = .38). Self-efficacy for self-regulated learning also predicted Internet self-efficacy (β = .26). The two variables together explained 22% of the variance in the Internet self-efficacy (R^2 = .22). Also consistent with our a priori hypothesis, Internet self-efficacy was able to predict students' performance on the WBI search test (β = .31). More important, Internet self-efficacy failed to relate significantly to students' written-test performance, while academic self-efficacy failed to relate significantly to their search-test performance. Magnitude of the relation between Internet self-efficacy and search-test performance (β = .31) was considerably greater than that between academic self-efficacy and written-test performance (β = .19). Unfortunately, the multiple R^2 values for both the WBI written (R^2 = .14) and search tests (R^2 = .17) were smaller than expected, suggesting that more pertinent variables should be included in future WBI research.

DISCUSSION

Windschitl (1998) observed that most research on WBI had been primarily descriptive in nature, with its emphasis on the technological aspects of classroom implementation. The use of the WWW for instructional purposes is a relatively novel phenomenon and many more descriptive studies on its hardware- and software-related problems and solutions will and should be under way. Equally important, however, is to find out whether and how student motivation and learning change under these new learning environments. The present study explored relationships among some of the important motivational variables, known to influence students' learning and performance in typical classroom settings, in WBI contexts. More specifically, it attempted to extend applicability of the self-efficacy theory into computer-mediated learning environments. The present investigation further examined effects of correspondence between self-efficacy beliefs and target performance on their predictive relations. Most hypotheses derived on the basis of the self-efficacy theory received support in the current WBI application, with few exceptions. Some relationships were not as strong as we originally anticipated but they were certainly suggestive.

Self-efficacy for self-regulated learning significantly related to students' confidence both in typical classroom learning and in using the Internet. Though self-regulatory self-efficacy did not predict students' final performances directly, it related to them indirectly through its direct links to more specific self-efficacy variables. The indirect effect of self-efficacy for self-regulated learning on achievement through various academic self-efficacy perceptions has already been documented (Bong, 1999; Zimmerman et al., 1992; Zimmerman & Bandura, 1994). Although smaller in magnitude compared with its relation to academic self-efficacy, self-efficacy for self-regulated learning showed a significant positive relation to Internet self-efficacy. Results of this study thus demonstrate that students' perceived capability for effectively regulating their learning processes is an important variable in computer-mediated learning. Students' scores on the written test were predicted only by their academic self-efficacy perceptions, whereas their scores on the search test were explained only by their Internet self-efficacy beliefs. From the theoretical perspective, this is more evidence of the need for correspondence between self-efficacy and performance assessments (Pajares, 1996).

On a macro level, present results corroborate previous findings that learners' attitudes and preconceptions toward media affect the learning outcomes (Salomon, 1984). On a micro level, they provide further evidence that computer self-efficacy is one of the critical variables determining the success of CBI and WBI (Al-Khaldi & Al-Jabri, 1998; Hill & Hannafin, 1997). Somewhat unsettling results concerned the two strategy-use variables. Contrary to our expectation, neither cognitive nor self-regulation strategy-use variables significantly related to performance. Assessment of strategy use in the present investigation relied solely on students' self-reports on items that referred to general academic events. Had different methods been used, it might have been possible to detect unmitigated effects of strategy use on performance. Accurate assessment of process variables such as learning strategy use has always been a thorny problem in educational research. More diverse methods of assessing strategy use such as observation, student interviews (e.g., Zimmerman & Martinez-Pons, 1988), and analysis of traces (e.g., Howard-Rose & Winne, 1993) or audit trails (e.g., Hill & Hannafin, 1997) will have to be pursued in future research. With its primary emphasis on student motivation in WBI, the current study admittedly involved only a limited number of variables presumed to influence WBI learning outcomes. In addition to assessing the use of learning and Web-searching strategies by diverse methods, more process variables need to be included in future WBI research to increase its practical relevance. Willingness to deploy specific strategies, persistence in the face of difficulties and temporary failures, and the number and nature of search paths actually taken are examples of such variables.

Finally, the present results indicate that teachers, trainers, and instructional designers of WBI would benefit by being more attentive to students' percepts of efficacy. Students who participated in the present study did not express uniform confidence across various Internet tasks described in the Internet self-efficacy scale. They were more confident toward some of the tasks and less confident toward others, sometimes noticeably so. If teachers have such information when planning their instruction, they can consider allocating some of the instructional time and activities to strengthening the weaker skills. Given the predictive utility of self-efficacy beliefs demonstrated by many previous and present findings, such effort seems worthy. ☐

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Appendix A ☐ Internet Self-Efficacy Scale[1]

I feel confident . . .

1. Starting the Internet program. (M)
2. Connecting to the Internet homepage that I want.
3. Finishing the Internet program during connection.
4. Downloading necessary materials from the Internet.
5. Linking to desired screens by clicking.
6. Going to previous pages by using "Back" function.
7. Going to next pages by using "Forward" function.
8. Scrolling around the monitor screen. (M)
9. Using Internet search engines such as Yahoo, Shimmany (Korean), and Kkachinnei (Korean). (E)
10. Locating necessary information on the Internet for a specific topic. (E)
11. Selecting the right search terms for Internet search. (E)
12. Printing materials located from the Internet. (E)
13. Finishing the Internet program. (M)

[1] E = adapted from Ertmer et al. (1994); M = adapted from Murphy et al. (1989).

Appendix B ☐ Sample Problems for the WBI Written and Search Tests

WBI Written Test

The following questions are based on materials from the previous WBI sessions.

1. Which of the following presents a correct classification of diseases?
   a. Respiratory organ disease—Coughing
   b. Endocrine organ disease—Leukemia
   c. Blood disorder—Obesity
   d. Digestive organ disease—High blood pressure
2. Which drug or substance is best described by the following characteristics?
   • Increases heartbeat and reduces the sense of balance when inhaled
   • Induces depression, fear, anxiety, and distortion of reality
   • Increases vulnerability to chronic lung diseases and lung cancer
   a. Thinner
   b. Canned Butane Gas
   c. Cigarettes
   d. Marijuana
3. Which of the following combination correctly represents normal blood pressure?
   a. Highest 140mmHg—Lowest 80mmHg
   b. Highest 160mmHg—Lowest 80mmHg
   c. Highest 140mmHg—Lowest 60mmHg
   d. Highest 160mmHg—Lowest 60mmHg

WBI Search Test

Search the following Internet site to answer the following questions:

http://edunet.kmec.net

1. Our excrement is tinged with brown because of the chemical substance named (   ).
2. Our fingernails are made of protein called (   ).
3. Our stomach contains acid but its inner wall is covered by (   ) that protects it from melting.

Search the following Internet site to answer the following questions.

http://www.haitai.co.kr/health/menu051.html

4. Which of the following is most likely to be contaminated to cause food poisoning?
   a. Fisheries
   b. Cereals
   c. Meat
   d. Vegetables
5. Which of the following is not a correct emergency treatment for a high-fevered patient?
   a. Put ice or a cold wet towel on the forehead
   b. Feed cooled water or barley tea
   c. Cleanse the body with lukewarm water
   d. Help the patient throw up