High-School Learners' Environmental Preferences, Personal Beliefs and Concept Achievements in the Web-based Context

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Abstract

This study investigated high-school students' preferences about the web-based learning environments, personal beliefs concerning epistemology and learning in the web-based context, and the effects of above variables on web-based concept learning. One hundred 11th graders participated in the study. For data collection, three questionnaires were used to detect the personal preferences and beliefs, and the flow-map technique was conducted to assess concept achievements. The descriptive statistics, t-test, correlation and regression analyses were employed to present overall trends of and interactions between variables. Result showed that students of the study had a moderate preference toward the explorative web-based learning environment and their belief in the positive learning consequences were only fair. In addition, participants displayed a dynamic form of personal epistemology. As for concept learning, the surface process was evident. It was found that the preference toward instructional configuration and the simple form of personal epistemology predicted the concept achievements.

1. Introduction

Personal environmental preferences and beliefs about epistemology and learning were found in many studies to be important predictors for science learning. Nevertheless, such research topics have not gained enough attentions in the web-based context. This study thus aims to explore the interactions between learners' preferences about the web-based learning environments, personal beliefs including epistemology and web-based learning, and the concept achievements.

2. Background

Many studies have shown that students' preferences toward learning environments were significantly associated with the academic achievement, attitude toward subject matters and study approaches (eg. Wierstra, et al., 1999 [1]; Kinchin, 2004 [2]; Chang and Tsai, 2005 [3]; Tsai & Chuang, 2005 [4]). Nevertheless, most of these studies were either conducted in the conventional classrooms or focused largely on the technical aspects of the web-based learning environments. Besides, although studies about

environmental preferences can be found in literature, few works analyzed the underlying determinants of the personal environmental preferences. With few studies directly addressing the issue, the underlying factors discussed in the study were actually suggested by research focusing on elements controlling learning behaviors. Among various psychological elements, the personal belief system is the most significant and frequently-mentioned psychological feature that regulates learning.

Literature reviews show that the components of the personal belief system can be distinguished from various standpoints. From the motivational perspective, studies indicate that learners' competence-related beliefs and control beliefs predict academic performances (Pintrich, P. R et al., 1993 [5]; Wentzel & Wigfield, 1998 [6]). Extended from the motivational perspective, Ajzen (2002 [7]) proposed the theory of planned behavior (TPB) which specifies the roles of beliefs toward learning consequences, social norms and control factors on learning behaviors. From the epistemological point of view, personal epistemology concerning beliefs about knowledge and knowing has been found to regulate human cognitive activities, including learning (eg. Hofer, and Pintrich, 1997 [8]; Schommer, 1993 [9]; Kuhn, 1991 [10]; Tsai, 1998 [11]; Yang, 2005 [12]). Basically, it was found that the more evaluative- or constructivist-oriented personal epistemology, the better results of knowledge construction and reasoning. In literature, various models of personal epistemology have been proposed with different theoretical dispositions. For example, many researchers emphasized the developmental nature (e.g. Perry, 1999 [13]; King & Kitchener, 1994 [14]; Kuhn, 1999 [15]), some claimed the independence between epistemological dimensions (Schommer-Aikins, 2002 [16]), whereas others argued the systematic or ecological interrelation (eg. Hofer, 2001 [17]). Regardless of which model can best represent the personal epistemology in the different opinions, the impact of personal epistemology on learning is found to be a universal phenomenon. Nevertheless, few studies placed such discussions in the web-based context.

In light of above researches, it was proposed in a previous report that personal beliefs including epistemological beliefs and beliefs about learning

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regarding ability, learning consequences and control factors should explain to some extent the learner preferences toward learning environment (Yang, Tsai, & Chang, 2006 [18]). To test the presumption, two questionnaires were developed to examine the learner preferences about the web-based learning environments in the pedagogical dimension (WLEP) and beliefs about web-based learning concerning learning consequences, effective conditions and difficulties (BWL). The previous study (Yang, Tsai, & Chang, 2006 [18]) found that university students preferred more of individual and structured instructional configurations while expected the outward mode of interaction. And, these subjects believed that there were underlying control factors, such as subject matters or topics and/or academic ability, mediating the success of web-based learning. Statistically, the correlation between preferences and beliefs was evident. In other words, in the web-based context, the personal belief system seems to interact with the displays of personal environmental preferences

As mentioned previously that learner preferences toward learning environments were significantly associated with the academic achievement, attitude toward subject matters and study approaches. Given that the displays of the personal environmental preferences are seemingly intervened by the personal belief system, the analysis on the environmental preferences should be extended to the underlying factors that can provide a clearer picture about the origin or the development of the personal preferences. Hence, this study made an attempt to explore the effects of personal environmental preferences and beliefs about epistemology and learning on science learning in the web-based context. It is hoped that such a study can provide a different perspective about the web-based learning.

3. Method

3.1 Subjects

Participants of this study were the one hundred 11th graders with 23 males and 77 females from three intact classes in a mid-size academic senior high school.

3.2 Instruments

Three questionnaires were used in the study. One is the Web-based Learning Environment Preference (WLEP) questionnaire developed previously by the authors of the study. The WLEP consisted of three instructional dimensions, namely the instructional approach, the cognitive process and the interaction system. The alpha value of each dimension was found to be higher than 0.7. By factor analysis, two to three factors were abstracted from each dimension whose alpha values ranged from 0.53 to 0.84. Another instrument is the Belief about Web-based Learning (BWL) questionnaire whose overall alpha was equal to 0.62 while the alpha values of the abstracted three factors, namely behavioral belief, contextual belief and perceived difficulty, ranged from 0.6 to 0.78.

To reveal personal epistemology, a 38-item Revised Epistemological Questionnaire (REQ) was employed. The REQ was reduced and adapted from the 63-item Schommer's Epistemological Questionnaire (SEQ) for high school students (Schommer, 2002 [11]). To obtain REQ, the SEQ was tested with over 370 10th graders in Taiwan. By explorative factor analysis, four epistemological factors were abstracted: (a) Quick Learning with 18 items (Alpha = 0.87), (b) Certain Knowledge with 6 items (Alpha = 0.65), (c) Simple Knowledge with 7 items (Alpha = 0.59), and (c) Innate Ability with 7 items (Alpha = 0.65).

To quantify the concept achievements, the flow-map method was applied. The flow-map method is a free-recall process which is proved to be good at detecting the sophisticated knowledge structures (e.g. Anderson & Demetrius 1993 [19]; Yang, 2004 [20]). Basically, participants were asked to write down first the concepts they could recall related to the target subject matter, and then explain each concept in details. Afterward, the researchers extract the conceptual propositions appeared in participants' writings and then make linkages among concepts. Two types of concept links can then be mapped. One is the serial links which indicate promptly recalled concepts while the other complex links implying the cross-connections between concepts. According to Anderson and others (1993 [19], 2001 [21]), the more complex concept links, the more sophisticated knowledge structure. Three independent coders conducted the coding process and the inter-coder correlations ranged from 0.85 to 0.91. The small coding differences were resolved through discussions.

3.3 Procedure

An issue-based, interactive online lesson on the topic of global warming was prepared for participants to experience various forms of online activities before the data collection. The web-based activities included a PowerPoint presentation, a data-analysis activity, some online-search activities, and some individual and between-groups discussions. In addition, topic-related short movies and animations were inserted in the lesson to provide visual experiences. Paired subjects were required to complete various online assignments and a group report. The lesson lasted for 8 hours in four days. The online test and the flow-map methods were conducted both before and after the online lesson while the WLEP, BWL and REQ were given to students after the completion of the lesson.

4. Findings

4.1 Preferences toward the web-based environment

As Table 1 shows, the mean score of the favored learning style was located at the middle of the individual and collaborative spectrum on the 4-point Likert Scale, suggesting that the participants might not like a completely collaborative learning task. In general, students preferred the inquiry-based instructional

configuration, expected accommodation-oriented cognitive activities and liked to engage in the outward interaction. Nevertheless, the mean scores suggested that students' preference toward the open and explorative web-based environment was only moderate.

Table 1. Student preferences about the web-based learning environment

Preferences	Mean (SD)	t
Learning style (individual – collaborative)	2.32 (0.51)	NA
Inquiry-based configuration	2.16 (0.43)	2.83**
Concept-based configuration	2.01 (0.38)	
Accommodation-based process	1.86 (0.45)	2.07*
Assimilation-oriented process	1.77 (0.43)	
Outward interaction	2.21 (0.55)	2.68**
Enclosed interaction	2.04 (0.38)	

**: p < 0.01

Further correlation analysis suggested that the preference toward the inquiry-based configuration were associated in a rather high degree with the accommodation-oriented cognitive processes and the preferences toward the outward interaction (r = 0.52 and 0.61 respectively, p < 0.01). Meanwhile, the preference toward the concept-based configuration was correlated more with the enclosed interaction (r = 0.56, p < 0.01) in comparison with the outward form (r = 0.35, p < 0.01). In addition, the preference toward the outward interaction was also found to be associated more with the preference toward the accommodation-oriented cognitive processes (r = 0.61, p < 0.01) than the association-oriented form (r = 0.45, p < 0.01). In short, those who preferred the inquiry-based and outwardly interactive web-based learning environment would also expect more of the sophisticated cognitive processes embedded in the learning task.

4.2 Belief about web-based learning

According to Table 2, the mean scores suggested that subjects of the study did not expect high behavioral consequences of web-based learning (behavioral belief, and seemed to believe that web-based learning might be difficult. However, their belief that there are specific factors, such as content and ability, controlling the web-based learning was low. By correlation analysis as also shown in Table 2, it was found that the behavioral belief was negatively correlated with the perceived difficulty while positively associated with the contextual belief. In other words, the higher belief in positive behavioral consequences, the more awareness about controlling factors but less perceived difficulty about web-based learning. The moderate correlation coefficients actually indicated the more or less independency between these belief factors.

Table 2. Factor means of belief toward the web-based learning (4-point scale)

Belief factor	Mean (SD)	Correlation		
		Behav.	Contex.	Difficu.
Behavior	2.06 (0.45)	1	0.20*	-0.30**
Contextual	1.86 (0.43)		1	-0.09
Perceived difficulty	2.81 (0.54)			1

**: p < 0.01; *: p < 0.05

4.3 Epistemological beliefs

The mean factor scores of participants' epistemological beliefs on a 5-point Likert scale obtained from REQ were listed in Table 3. As the table shows, students gave relatively higher weights on the factors of Quick Learning and Simple Knowledge while they seemed to believe less in Certain Knowledge and Innate Ability. The correlation coefficients as also displayed in Table 3 implied that these epistemological factors were more or less dependent in particular that belief toward quick learning is strongly associated with belief toward simple knowledge.

Table 3. Factor scores and correlations of epistemological belief from REQ revised from Schommer's Epistemological Questionnaire (SEQ)

Epistemological factor	Mean (SD)	Correlation			
		Q	C	S	I
Quick learning (Q)	3.87 (0.54)	1	0.23*	0.50**	.052
Certain knowledge (C)	2.55 (0.68)		1	0.35**	0.29**
Simple knowledge (S)	3.37 (0.45)			1	0.17
Innate ability (I)	2.51 (0.68)				1

**: p < 0.01; *: p < 0.05

4.4 Concept achievement

As mentioned previously, the concept performance that played an indicator of web-based learning result was assessed by the flow-map method. The flow-map method extracted individuals' recalled concepts, and the amounts of serial and complex concept links were measured for analysis. Table 4 shows means, the paired-t tests and the effect sizes of concept achievements. According to the analyses, participants had significant concept achievements after going through the web-based lesson. However, the effect sizes showed that the achievement was more significant on the serial concept links.

Table 4. Means and paired-t tests of the online test results and flow-map performances

Amount of concept links	Mean (SD)	t / effect size
Pre serial links	5.69 (4.11)	
Post serial links	8.70 (4.81)	t = 6.13**
Pre complex links	0.34 (0.92)	
Post complex links	0.58 (1.06)	t = 2.01*
Net serial links	3.00 (4.87)	Effect size = 0.72
Net complex links	0.23 (1.15)	Effect size = 0.25

**: p < 0.01; *: p < 0.05

4.5 Interactions amount preferences, beliefs and concept performances

To explore the interactions between preferences and beliefs about web-based learning, the correlation analyses were conducted as shown in Table 5.

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Table 5. Correlations between environmental preferences and beliefs about web-based learning

Preferences \ Belief	Behavioral belief	Contextual belief	Perceived difficulty
Learning style	-0.07	-0.15	*0.17(*)*
Concept-based configuration	**0.37****	**0.23***	-0.04
Inquiry-based configuration	**0.50****	**0.31****	**-0.22***
Accommodation-oriented process	**0.57****	**0.26****	**-0.25***
Assimilation-oriented process	**0.32****	**0.28****	**-0.24****
Enclosed interaction	*0.19(*)*	*0.18(*)*	0.03
Outward interaction	**0.47****	**0.36****	-0.10

**: p < 0.01; *: p < 0.05; (*): p < 0.1

Table 6. Correlations between preferences toward the web-based learning environment and serial concept achievements

Concept links Preference	Pre S-Links	Post S-Links	Net S-Links
Learning style	*-0.18(*)*	0.03	*0.18 (*)*
Concept-based configuration	0.09	-0.03	-0.11
Inquiry-based configuration	-0.08	-0.08	-0.01
Accommodation-oriented cognitive process	-0.13	**-0.22***	-0.11
Assimilation-oriented cognitive process	-0.10	**-0.26****	*-0.17 (*)*
Enclosed interaction	0.06	0.08	0.03
Outward interaction	0.09	**-0.24***	**-0.31****

**: p < 0.01; *: p < 0.05; (*): p < 0.1

It was found that the higher behavioral belief toward the web-based learning (i.e. belief about the positive learning consequences) and contextual belief (i.e. belief about controlling factors), the higher preference toward the inquiry-based and outwardly interactive environment. On the other hand, the awareness about difficulties in web-based learning seemed to hinder the preference toward the inquiry-based environment.

For preferences and epistemological beliefs, a negative correlation was found between belief in simple knowledge and the learning style (r = -0.21, p < 0.05) which meat that the more belief in simple knowledge, the less preference toward the collaborative learning style. Noticeably, there is an approximately negative correlation found between belief in innate ability and preference toward the enclosed interaction (r = -017, p < 0.1). That is, the more belief in the innate learning ability, the less preference toward the enclosed interaction. On the other hand, no correlation was found between beliefs about web-based learning and the epistemological beliefs. Seemingly, the two kinds of belief structures are independent to each other.

To see the effects of preferences and beliefs on concept achievements, the correlation and regression analyses were performed. As shown in Table 6, an approximate correlations were found between the preference toward the collaborative learning styles and the net serial links (r = 0.18, p < 0.1). The preference toward the assimilation-oriented process were found to be negatively correlated with the post serial links (r = 0.-26, p < 0.05) and the net serial links (r = -0.17, p < 0.1). Meanwhile, the preference toward the outward interaction was found to be negatively correlated with the post serial links (r = -0.24, p < 0.05) and the net serial links (r = -0.31, p < 0.01). However, no correlation was found between the environmental preferences and the complex concept links.

Remarkably, when the concept achievements were regressed on the environmental preferences with the stepwise procedure, it was shown that the preference toward assimilation-oriented cognitive process was a negative predictor (t = -2.67) for the post serial links (F = 7.13, R^2 = 0.07, p < 0.05). Whereas, the preferences toward the inquiry-based instructional configuration (t = 2.05) and the outward interaction (t = -3.81) together predicted the net serial links (F = 7.26, R^2 = 0.13, p < 0.01). In other words, the concept achievements assessed by the flow-map method, especially in the serial form, was positively affected by the preference toward the inquiry-based instructional configuration while deterred by the preferences toward the association-oriented cognitive process and the outward interaction.

As far as the beliefs about web-based learning were concerned, a negative correlation was found between the behavioral belief and the post serial links (r = -0.25, p < 0.05). And, the contextual belief was also negative associated with the post serial links (r = -0.2, p < 0.05). Table 7 listed the overall coefficients. Noticeably, the contextual belief was also found to be somewhat negatively associated with the post complex links (r = -0.17, p < 0.1). In brief, the above findings suggested that the more positive belief in the web-based learning consequences (i.e. behavioral belief) and contextual considerations (i.e. belief about control factors), the less achievements in the concept learning. Regression analysis showed that the behavioral belief negatively predicted the post serial links (F = 6.50, p < 0.05, R^2 = 0.06, t = -2.55).

Table 7. Correlations between belief about the web-based learning and concept achievements

(a) Serial concept links

Concept Belief	Pre S-links	Post S-links	Net S-links
Behavioral belief	-0.07	**-0.25***	*0.19(*)*
Contextual belief	-0.09	**-0.20***	-0.16
Perceived difficulty	-0.03	0.09	0.11

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(b) Complex concept links

Concept / Belief	Pre C-links	Post C-links	Net C-links
Behavioral belief	0.04	-0.06	-0.02
Contextual belief	0.00	*-0.17(*)*	-0.16
Perceived difficulty	0.13	0.04	-0.07

*: $p < 0.05$; (*): $p < 0.1$

As Table 8 displayed, the correlation between epistemological factors and concept achievements was apparent between belief in quick learning and achievements in the serial links (r = 0.21 and 0.20 for post and net serial links respectively, r < 0.05), while belief in innate ability seemed to associate with the pre-serial links (r = 0.18, p < 0.1). However, no correlation was found between the personal epistemology and the achievements regarding the complex concept links. By regression, belief in quick learning was revealed to be a predictor for the post serial concept links (F = 4.38, p < 0.05, R^2 = 0.04).

Table 8. Correlations between personal epistemological belief and the serial concept achievements

Concept / Belief	Pre S-links	Post S-links	Net S-links
Quick learning	0.01	**0.21***	**0.20***
Certain knowledge	-0.05	0.03	0.08
Simple knowledge	-0.12	0.02	0.12
Innate ability	*0.18(*)*	-0.02	0.13

*: $p < 0.05$; **: $p < 0.01$; (*): $p < 0.1$

Moreover, to see the effects of overall preferences and beliefs on the concept performance, the net concept links was regressed on all the preference and belief factors. It was found that the preferences toward the inquiry-based configuration and outward interaction and belief in quick learning stood out as predictors for the net serial concept achievement (F = 6.18, p < 0.01, R^2 = 0.16, and t = 2.02, -3.78, 1.98 respectively, p < 0.05).

5. Discussion

This study investigated high-school students' preferences about the web-based learning environments, beliefs about epistemology and web-based learning, and then discussed the effects of these variables on concept performances after subjects completed a web-based lesson. Based on the comparisons between factor means, this study revealed that the participants of the study favored more of the inquiry-based and outwardly interactive web-based environment. However, the mean scores indicated only a moderate degree of favorite. Moreover, their preferred learning style was a mixture of individual and collaborative form. In addition, the significant inter-factor correlations indicated that the preferences toward different instructional dimensions were systematically connected. Above findings suggested that when placed in the web-based learning environment, high-school learners may still want to be guided more or less by instructors or the structured instructional design even though they showed willingness to engage in the explorative and interactive learning.

The factor means regarding beliefs toward web-based learning showed that students of the study did not place a high expectation on positive web-based learning consequences, and they seemed to think that the web-based learning could be difficult. Besides, these subjects seemed to care less the factors such as subject matter and individual ability that might control web-based learning. By correlation, a significant association was found between behavioral belief and preference toward the explorative and interactive environment as displayed in Table 5. This finding suggested that the preference toward some certain kinds of learning environment was affected by beliefs about perceived learning processes and consequences.

As far as the epistemological beliefs were concerned, subjects of the study displayed a rather diverse personal epistemology in that they seemed to agree with quick learning and simple knowledge, while in the same time had doubts on the certain knowledge and the innate ability. From the developmental point of view, this finding implied that participants of the study who were in the 11th grade may be moving from simple toward the more complicated form of personal epistemology. In relation with the environmental preferences, the cross correlation showed that the epistemological belief was associated only with learning style in which the more belief in simple knowledge, the more preference toward the individual learning style. Furthermore, no correlation was found between personal epistemology and belief about web-based learning. Above findings suggested that the personal epistemology is seemingly independent from constructs regarding environmental preferences and beliefs about learning in the web-based context.

According to the result of the flow-map method, participants in the study displayed significant concept achievements after completing the web-based lesson. However, the achievements were more statistically evident with respect to the serial form of concept links. The achievements in the complex concept links which indicated sophisticated concept structure received only a low effect size. The effects of environmental preferences and personal beliefs about epistemology and learning on concept achievements were analyzed by the regression analyses with stepwise procedure. It was found that preferences toward the inquiry-based instructional configuration (positive predictor) and outward interaction (negative predictor) and belief in quick learning (positive predictor) together predicted the serial concept achievements. In summary, the result of the study revealed that although the web-based lesson presented in the study was largely inquiry-based and interactive, which was thought to promote knowledge construction, with a moderate preference toward the

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explorative environment and belief in quick learning, students would initiate a more surface learning process rather than a deep process,

Accordingly, to promote sophisticated concept learning in the web-based learning environment, it is recommended that prior to the learning activities, the instructor would need to demonstrate to learners the positive learning consequences that will occur with the desired web-based instructional design so that learners can establish high behavioral intention about web-based learning. The high behavioral intention will further promotes high preferences toward the desired web-based instruction, which will then help to bring about successful concept learning. However, it should be noticed that even in an explorative and interactive learning environment which is thought to be constructivist-oriented, the concept learning might still be a surface process if the learner does not have a relevant personal epistemology. Given that belief in quick learning seems to promote serial concept achievement as the result of the study showed, more studies are in need to examine whether a more advanced epistemological status will encourage more sophisticated concept learning.

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