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Individual Differences in Computer-Mediated Communication for Web-Based Learning

Lih-Juan ChanLin

Professor
Department of Library & Information Science, Fu Jen Catholic University
Taipei, Taiwan
E-mail: lins1005@mail.fju.edu.tw

Abstract

The learning process in online learning environment involves interactions among students, interaction between instructor and students, and collaborations in learning that result from these interactions. Students' involvement in online interaction might relate to individual differences. The relationship between individual differences and students' learning and actions in online interaction needs to be explored. In this study, a web-based learning course "Computer Ergonomics" was employed to collect students' online interaction data. Learning tasks and a project assignment were embedded in the course as a way to foster self-directed learning. The main focus of the study were to examine 1. how individual differences related to students' actions in online discussion and their reactions toward learning, and 2. whether students with different levels of involvement in online discussion differed in their learning outcomes. Both qualitative and quantitative approaches were used in the research to analyze students' verbal responses in the discussion forum. Students' responses were categorized and counted for further analysis. Various indications, including gender, cognitive style, and use of study strategies were used as variables for analysis of response types among students. In addition to discussion data, students' learning portfolios, project assignments and work sheets were also gathered for further analysis. The results of the study indicate that some of the variables correlated significantly with students' action and socialization in online discussion and their learning reactions. Students' with different levels of involvement performed differently ($p < 0.0001$).

Keywords: *Computer-mediated communication; Web-based interaction; Web-based discussion; Computer-mediated discussion; Cognitive styles; Individual differences*

Introduction

Online learning has emerged as a prominent aspect of higher education's mission. Technological advances in online learning have resulted in a myriad of media available for educators to deliver course materials. Attracting a global body of teachers and students is the interactive feature of this mode of learning. Learners

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can choose the time, pace, and place for learning and accessing various forms of media and interactions (Stewart et al., 2006). One of the most important reasons for investing in web-based technology is its potential to enhance teaching and learning interactions, as well as to encourage the development of student-centered learning and to foster a deeper approach to learning (Mimirinis & Bhattacharya, 2007). From a constructivist prospective, knowledge is communicated through conversation, whether face-to-face or electronic, and whether spoken or written (Cognition and Technology Group at Vanderbilt, 1996). However, some quality issues of online learning were pointed out by other researchers including the lack of effective administration of students' learning and the lack of social interaction during online learning (Muilenburg & Berge, 2001). It is important to make use of online interaction tools to enhance and extend communicative activities among students. In an effort to address the individual differences in online learning and interaction, many past studies sought to examine how institutional and learner factors influenced the overall quality of online learning program. However, less known in the literature are the mediating variables or mechanisms at a course level influencing specific outcomes of online learning (Lim, Morris, & Yoon, 2006).

Developments in technologies available for the design and delivery of learning have encouraged a strong emphasis on interactive learning design and delivery that is more closely in line with learner requirements and context. The support of a constructivist approach to learning in online setting has also made learning and teaching progress from simply presenting course content online to encouraging active learning and knowledge-creating environments that immerse students in their work (Ladner et al., 2004; Waight et al., 2002). As technology pervades higher education, educators should be mindful of what media and materials can lead to successful learning for the various individuals the course will be reaching. However, the diversity of individual differences among learners has made design and development of online courses more challenging to educators (Jenkins et al., 2001).

Conventional approaches to the design of programs for learning and training sometimes have typically been developed from instructional approaches under the assumption that the target learners exhibit uniformity in the ways in which they process and organize information and in their predispositions towards specific learning situations and media (Sadler-Smith & Smith, 2004). Since in the technological world, the learners are provided with more freedom and control over the presentation materials and online learning activities, individual differences between learners might impact their learning motivation and outcomes (Lee et al.,

2006). In order to maximize learning potential, various learning approaches need to be tailored to individual differences among students in various learning settings to meet learners' personal needs (Frias-Martinez et al., 2007; Jenkins et al., 2001).

In web-based learning settings, learners' individual characteristics have been extensively studied in the context of computer-mediated environment (Lee et al., 2006; Carson, 2006; Sadler-Smith & Smith, 2004; Jenkins et al., 2001). Individual differences can be reflected from various learners' characteristics, such as demographic information, learning styles/preferences, technology skills, and learning motivation on online learning (Lim et al., 2006). Individual characteristics can also be seen in the habitual way in which people prefer to learn and perceived information, for example, prior experiences and skills for using online communication tool, or students' attitudes toward school (Fishman, 1999). Various factors have been employed to observe individual differences related to web-based learning environment. For example, gender-based differences were observed among adult learners in various dimensions, including computer literacy (Wilson et al., 2006), sense of community, perceived learning, and interpersonal interactions (Rovai & Baker, 2005). Contreras (2004) interprets individual differences in computer self-confidence, demography, personality variables, and use of computer. Salend (2005) emphasizes individual differences related to disabilities and the development of technology-based strategies to accommodate individuals' special needs. Hoskins & van Hooff (2005) examine the influence of individual differences in motivation and ability on students' online learning achievement. Frias-Martinez et al. (2007) interpret cognitive styles as relevant parameters that affect information seeking in digital library.

With respect to different forms of communication available in web-based setting, some studies have examined the types and roles of interactions in web-based learning environment (Hirumi, 2002; Northrup, 2001). Individual differences in expressing their needs and reactions towards the computer-mediated interaction have become a focus of research interest. Roy (2006) considers the impact of individual differences in learning styles on interactivity in asynchronous e-learning. Lin et al. (2005) observe individual differences in their psychological-type preferences associated with their responses to online learning as reflected in their sense of enjoyment and their online participation and in the quality of their learning experience. Mupinga et al. (2006) identify students' online interaction needs from the aspect of individual differences in the following dimensions of learning styles: extroversion vs. introversion, judging vs. perceiving, sensing vs. intuition, and thinking vs. feeling. Jeong & Davidson-Shivers (2006) explain

gender differences in participation, group interaction, and use of strategies for facilitating collaborative argumentation and problem-solving in computer-mediated communication. Using Learning and Study Strategies Inventory (LASSI) to define individual differences, Wellman (2005) concludes that some constructs, such as anxiety, self-testing, attitude/interest and motivation are significant in predicting online learning for proctored environment settings.

The literature of web-based learning applications suggests that students' outcomes are more accountable when individual knowledge gains and learning applications are demanded simultaneously during learning (Lim et al., 2006). However, the inter-connected alignment among individual characteristics, instructional conditions, and other learner variables for affecting course outcomes are crucial to successful implementation. The need to identify the mediating mechanisms that link contextual features influencing online learning outcomes has been pressing research interest among researchers.

Research Question

The purpose of this research was to examine online learners' different action patterns in participating online interactions. Individual differences, such as cognitive style in field-dependence, gender, and use of study strategies were identified. This study purported to identify how various variables in individual differences related to students' course outcomes and online actions. Two research questions were developed to investigate the study purpose: 1. how individual differences related to students' actions in online discussion and their reactions toward learning, and 2. whether students with different levels of involvement in online discussion differed in their learning outcomes.

Method

Participants and instructional setting

Participants of this study were 42 undergraduate students (10 males and 32 females), who took the elected course, Media Services at the Department of Library & Information Science, Fu-Jen Catholic University, Taiwan. A part of the course was designed for asynchronous online learning covering the subject area of computer ergonomics. Various types of media such as texts, graphics, audio, and video clips were employed to present the instructional contents delivered through the web (http://mediser.lins.fju.edu.tw). The participants were divided into peer groups composed of three to four students who were involved in group projects and various online activities for group engagement and learning course that required completion of six lesson units in 12 weeks (from October, 2006 to January,

2007). Unit tasks were assigned every two weeks. Students were requested to study independently by themselves and cooperatively with peers. The workload of each lesson unit was equivalent to that of one week's classroom instruction. The online lesson units provided subject content and resource links to web-based reading materials. Students were encouraged to discuss and reflect on what they learned and read. They were requested to send more than five postings per week. The learning system managed administrative tasks for students' learning including grade posting, announcement posting, group formation, and communications. Each student was required to complete various learning activities and assignments including group discussions, midterm-exam, unit assignments, and a final group project (a research paper on ergonomics issues). These learning activities aimed not only to assist learning, but also to facilitate the online learners in applying acquired knowledge and skills while learning.

Data collection and analysis

When analyzing individual differences, various data were used prior to online learning. In determine students cognitive styles, Group Figure Embedded Test (GFET) from the work of Witkin (1962) were used to determine students cognitive style based on their field dependence—field dependence (FD) or field independence (FI). Since it is noted that compared with FI students, FD students' learning require more use of structural learning setting and external help for selecting main idea from instructional content (Chen & Macredie, 2002; Carson, 2006), necessary adaptations could be made according to the prior assessment of learners' characteristics. From the aspect of strategy use in preparing academic works, LASSI (Learning and Study Strategies Inventory) from the work of Weinstein (1987) was used to pre-assess students' use of traditional strategies. During the learning process, students' performance was assessed by their assignments, midterm exam, and final group projects. Overall responses toward the web-based content and the web-based interaction were assessed using a set of pre-determined questionnaire items (24 items for instructional content and 16 items for online interaction). For example, the items such as "The content of computer ergonomics is important to me", "I felt what I had learned from the web-based lesson could be applied in future", and "I was satisfied with the designed content of the lesson" were used to assess student's reactions toward instructional content. The items such as "From the flow of web-discussion, it was easy for me to attend to the key points in the lesson", "From the online discussion, I obtained potential learning interest in the content", "From the online discussion, I could make sense of the learning content", and "Web-discussion in the lesson was helpful for accomplish-

ing learning tasks given" were used to assess students' reactions towards the online interaction. These items used 5-point Likert Scale to reflect a response from "strongly disagree" to "strongly agree".

For the analysis of students' characteristics in their web-based actions, the primary data sources used in this study were from the postings of online discussion forums. Students' interactions with their peers and their instructor were documented for further content analysis. For reference of the responses, students' postings were coded according to their ID Number followed by their group number and date of posting. For instance, "167-01-20061030" denotes the posting of Student ID 167 from Group 1 posted on October 30, 2006.

Results

Students' differences and online adaptation

Traditional instruments for determining students' differences were used prior to learning. Analysis of students' cognitive styles indicated that 12 (30%) were field-independent (FI) and 28 (70%) were field-dependent (FD). LASSI employed for examining students' use of traditional learning strategies revealed that the mean scores (using 5-point Likert Scale) of some constructs in LASSI were relatively low (< 3.0), including "Attitude", "Selecting main ideas", and "Test strategies" as shown in Table 1. Students' online interactive involvement was assessed by tallying their postings to see if they met the minimum personal postings required. (Each student should have at least five postings per week.) Twenty-four students were identified as low involvement (number of postings below minimum requirement), and 18 were high involvement (number of postings above minimum requirement). Mean total postings for low-and high-involvement students were listed in Table 2.

Table 1 Learning and Study Strategies Inventory (LASSI)

Construct	Min	Max	Mean	SD
Attitude	2.14	3.71	2.74	0.44
Motive	2.29	4.00	3.00	0.33
Time management	2.78	4.11	3.28	0.33
Anxiety	1.63	4.75	3.12	0.65
Concentration	2.63	4.13	3.32	0.41
Information processing	2.56	4.56	3.38	0.44
Selecting main ideas	1.67	2.67	2.10	0.24
Study aids	2.57	4.43	3.43	0.38
Self-testing & reviewing	2.33	3.78	3.28	0.34
Test strategies	1.56	3.00	2.33	0.33
Problem solving	2.78	4.33	3.33	0.35

Table 2 Involvement of online interaction

Involvement	Mean total postings	N	SD
Low	48.17	18	17.63
High	83.42	24	6.55
Total	68.31	42	22.45

Among the target learners, it was observed that the majority of students were FD individuals (70%), with negative attitude toward learning and limited use of internal learning strategies for selecting main ideas and preparing for tests. Categories in LASSI for "Attitude", "Selecting main ideas", and "Test strategies" were 2.74 ($\pm$ 0.44), 2.10 ($\pm$ 0.24), and 2.33 ($\pm$ 0.33) respectively. Externally directed strategies for fostering positive learning attitude, selecting main ideas and testing strategies were implemented in the learning setting. For examples, using brief summary for reading of web-resources, peer contacts for reminding tasks to be accomplished, tracking of individual learning progress and responses regularly, and appropriate exercises and assignments were emphasized in the web-based learning setting. The use of these external strategies aimed to help students in becoming self-regulated and self-disciplined in their own learning. Online instructional adaptations were listed in Table 3. Students were requested to regularly log-on and submit postings almost a daily basis. Frequency counts for students' postings were reported online and accessed individually using their own passwords.

Table 3 Online Instructional Adaptations

Characteristics of students	Online adaptations
Most students were FD (70%), required the use of structural learning setting, help for capturing main ideas from instructional content, and various learning aids for study.	Used frequent reminding, and external incentives. Used study guide and AV media embedded in the instructional content to help students relate important ideas, for example: • flow charts and study aids for procedures in accomplishing tasks • brief summary in each reading section • reading outline for web-resources • both verbal audio-visual media guidance
Students' attitude toward learning is below average (Mean = 2.74 $\pm$ 0.44 in LASSI). Most were inclined to learn passively, and required external reinforcements to help identify and accomplish their own learning goal	Adapted group learning and used worksheet to help students identify important learning tasks to be accomplished and fulfill their learning goals, for example: • informing value of the learning content • electronic peer contacts • exercises and practices • frequent verbal feedback • verbal rewards

Students were lack of strategies in selecting main ideas (Mean = 2.10 ± 0.24 in LASSI). Most were not well in self-regulating their learning.	Provided study guidance for learning, and allowed students to have access to their own learning status, for example: • frequent guidance for use of strategies in exploring web-based resources • access to one's own learning status • guidance for preparing unit tasks • self-review and self-reflection
Most students were lack of test strategies (Mean = 2.33 ± 0.33 in LASSI) Students needed frequent reminding and external incentive for accomplishing learning tasks and learning objectives	Reminded students to keep their own progress, and encouraged students' use of their own notes in recording what they found and learned, for example • explanations of criteria for what and how to be evaluated • tips for learning important concepts • frequent reminding of time to accomplish tasks • self-test items derived by students • use of note-taking techniques • providing tips to get good grade

Actions in online discussion

To fulfill the class requirement in the web-based course, students were obliged to interact with their peers in each class unit. A total of 2869 postings were gathered from students' discussion forums. Since in web-based learning setting, the discussion forum was used as a tool for exchange of ideas and learning thoughts, students' postings were used for content analysis. These postings were analyzed on a qualitative basis, and grouped into four main action categories to reflect students' behaviors in online discussion, including "Referencing information" (613 postings), "Experience sharing" (1028 postings), "Organizing" (646 postings), and "Socializing" (582 postings). These actions were briefly described as follows:

* Referencing information

In the category of "Referencing information", students' use of references for discussion was observed. Learning the "Computer Ergonomics" web-based lessons was not limited to the content presented on the course website, students were provided with opportunities and incentives for accessing various resources independently and sharing these materials with peers collaboratively. Instead of copying and pasting information from other websites, students listed reference URL for further discussion. Providing resource links allowed group members to reflect and refer to the information given. From the discussion forum, a total of 613 postings were classified as "Referencing information". Examples for these postings are listed in Table 1.

* Experience sharing

In this category, students posted information for relating learning with their own personal experiences. Since learning computer ergonomics was relevant to students' real-life experiences, students drew their own examples. For instance, students related the learning content to their own computer ergonomics problems, and shared experiences and ways of avoiding threats from use of computer. Some students also brought in the cases and experiences from their friends and family members or from the cases in their libraries. A total of 1028 postings were included in "Experience sharing". Examples for these postings are listed in Table 4.

* Organizing

To accomplish their assignments and group project, students need to organize resources from various websites, course contents, and experiences individually and collaboratively. Potential effort and critical evaluation of the materials available and prioritizing elements to be included in each assignment and the final project was important. From the "Organizing" category, students' postings for presenting personal organization of their allotment of learning tasks were grouped. A total of 646 postings were included in this category. Examples for these postings are listed in Table 4.

* Socializing

Since the interdependent relationships among team members was critical in a team work, students communicated socially to establish and reinforce their personal relationships with others. In their actions of "Socializing" students' postings covered reminding other team members for the jobs to be done, and clarifying for available choices, tasks or aids. In addition, providing peers with important information, assigning job responsibilities and other informal chatting were also observed. The contents of students' postings in "Socializing" reflected differences in their personality and social styles in group interaction. Some students preferred chatting informally and humorously. Specific language and verbal expressions used among youngsters were observed. A total of 582 postings were included in this category. Examples for the postings are listed in Table 4.

Within the category of "Socializing", students' actions contain responses for clarifying misunderstandings or uncertainties from their communication (53 postings for "Clarifying"), reminding group members for the shared tasks (94 postings for "Reminding"), informing group members of one's decisions (157 postings for "Informing"), assigning responsibilities for group tasks (40 postings for "Assigning tasks"), chatting for holding group members together (126 postings for "Chatting"),

and personal thoughts toward an issue or a task (112 postings for "Reflecting"). Examples for these postings are listed in Table 4.

Table 4 Categorization of Online Postings

Categorization		Example	Counts
Referencing information		"Treatments and medications for RSI are different depending on the causes and symptoms….. http://www.chiropractic.on.ca/chiropractic_library_ergonomics_survey.html" (117-11-20061016) "The information was obtained from the website: ….." (325-07-20061102)	613
Experience sharing		"To prevent CTS, we need to remind ourselves to rest after working with computer every 20 minutes." (351-11-20061020) "I am often too close to my computer screen. For my own health sake, I need to adjust my own habit while working with computers" (181-09-20061127) "In the library I served, various ideas for improving accessibility had been discussed before. However, the budget and available resources were often very limited." (167-01-20070106)	1028
Organizing		"Some foreign websites provide information in planning for ergonomic computing, I have summarized the information as follows….." (272-04-20061031) "Planning for accessibility in library is needed. Considerations for visual and physical impairment are necessary for making library more accessible to all users." (129-09-20061218)	646
Socializing	Clarifying	"What are the topics we can choose from?" (155-02-20070106) "What is your stand? Assent or dissent?" (076-10-20070105)	53
	Reminding	"We are behind schedule. Please hurry up." (167-01-20061030) "We must follow the discussion rules. Use the proper words for conversation." (301-08-20061015)	94
	Informing	"Please share the cases of RSI problems you experienced under this topic." (179-08-20061029) "Please post related information here." (193-04-20061015)	157
	Assigning tasks	"We need to discuss what each of us is responsible for." (155-02-20061215) "Each of us needs to summarize two of the cases identified. Please give a brief introduction first, and then describe the points you made." (052-02-20070106)	40
	Chatting	"Cool!" "I am here!" (387-10-20061016) "Are you taking a Time Machine to get here?" (129-09-20061015)	126

Reflecting	"I would like to reflect on this point you mentioned. Many organizations have worked on various digital standards to improve the accessibility and use of digital resources among special users." (325-07-20061227) "This assignment is more difficult than the previous one. Reading references in English is tough for me." (478-11-20061030)	112

Online actions and performance

Students' performance was evaluated by their assignments, mid-term exam, and final project (Table 4). Their final scores were obtained from unit assignments (50%), mid-term exam (20%) and final project (30%). The mean score for each of the above were listed in Table 5. As can be seen, all students achieved their learning objectives, with a mean final score of 77.84 (SD = 5.61). The overall assessment of students' reactions toward the web-based learning content and online discussion conducted at the end of the course revealed positive learning responses from the learning experience. Mean scores for reactions toward the web-based learning were 3.84 ($\pm$ 0.81) for the instructional content and 3.70 ($\pm$ 0.49) for online interaction. Specifically, students reacted more positively toward the web-based interaction in the following response items: "The web-discussion in the lesson unit was helpful for obtaining more relevant knowledge" (mean = 4.10 $\pm$ 0.91), "Web-discussion in the lesson helped me become more involved in learning tasks relevant to my learning objectives (mean = 4.12 $\pm$ 0.83), and "Web-based discussion enabled me to experience different ways of accomplishing team tasks (mean = 4.00 $\pm$ 0.83).

Table 5 Students' Learning Outcomes in Web-based Learning

Assessment	Mean score	SD
Unit 1	69.93	11.55
Unit 2	77.10	12.79
Unit 3	81.07	6.09
Unit 4	83.63	3.79
Unit 5	72.95	13.27
Mid-term exam	72.90	10.43
Group project	82.57	4.08
Final score	77.84	5.61

Differences in online behavior between gender & cognitive styles

Analyzing number of postings in discussion forums revealed variations in the percentage of their actions within different genders and cognitive styles. Within the gender aspect, the greatest percentage of postings was "Experience sharing" in females (38.7%) and "Referencing information" in males (30.8%)

(Table 6). Within the cognitive-style aspect, the greatest percentage of postings was "Organizing" in both FD and FI students (35.51% and 36.39% respectively) (Table 7).

Specifically, from the percentage of students' postings in the category of "Socializing", the greatest percentage of postings was "Informing" in females (26.1%), and "Reflecting" in males (28.0%) (Table 8). Within the cognitive-style aspect, the greatest percentage of postings was "Informing" in FD students (33.62%), and "Reflecting" (24.25%) in FI students (22.94%) (Table 9).

Table 6 Number of Postings for Actions in Different Genders

Type of Category	Female (%)	Male (%)
Referencing information	387 (18.1)	226 (30.8)
Experience sharing	826 (38.7)	202 (27.6)
Organizing	515 (24.1)	131 (17.9)
Socializing	408 (19.1)	174 (23.7)
Total	2136 (100)	733 (100)

Table 7 Number of Postings for Actions in Different Cognitive Styles

Type of Category	FD (%)	FI (%)
Referencing information	451 (24.90)	195 (18.43)
Experience sharing	366 (20.21)	247 (23.35)
Organizing	643 (35.51)	385 (36.39)
Socializing	351 (19.38)	231 (21.83)

Table 8 Number of Postings for Different Socializations in Different Genders

Type of Socializing	Female (%)	Male (%)
Requesting information	44 (8.7)	9 (5.5)
Reminding	69 (19.1)	25 (14.5)
Informing	117 (26.1)	40 (26.1)
Reflecting	74 (18.3)	38 (28.0)
Assigning tasks	32 (7.6)	8 (3.4)
Chatting	72 (20.2)	54 (22.5)
Total	408 (100)	174 (100)

Table 9 Number of Postings for Different Socializations in Different Cognitive Styles

Type of Socialization	FD (%)	FI (%)
Requesting information	31 (8.83)	22 (9.52)
Reminding	48 (13.68)	46 (19.91)
Informing	118 (33.62)	39 (16.88)
Reflecting	56 (15.95)	56 (24.25)
Assigning tasks	25 (7.12)	15 (6.49)
Chatting	73 (20.80)	53 (22.94)

Correlation analyses of postings for various actions with gender and cognitive style were conducted. The results showed only a significant correlation between the action of "Experience sharing" and gender (r = 0.577, p = 0.000) (Table 10) but insignificant between any action and cognitive styles. Within the "Socializing" actions, gender correlated significantly with "Chatting" (r = 0.351, p = 0.023); and cognitive style correlated significantly with "Reminding" (r = 0.347, p = 0.024) and "Reflecting" (r = 0.333, p = 0.031) (Table 11).

Table 10 Correlations between Online Actions with Gender and Cognitive Style

Type of Category	Correlation between online actions and gender		Correlation between online actions and cognitive style	
Referencing information	r = –0.117	p = 0.459	r = –0.094	p = 0.552
Experience sharing	r = 0.577	p = 0.000***	r = 0.278	p = 0.075
Organizing	r = -0.179	p = 0.256	r = 0.160	p = 0.310
Socializing	r = 0.222	p = 0.157	r = 0.210	p = 0.182
Total	r = 0.126	p = 0.427	r = 0.232	p = 0.140

*** $p < 0.001$

Table 11 Correlations between Online Socialization with Gender and Cognitive Style

Type of Category	Correlation between online socialization and gender		Correlation between online socialization and cognitive style	
Requesting information	r = –0.143	p = 0.366	r = 0.155	p = 328
Reminding	r = 0.069	p = 0.666	r = 0.347	p = 0.024*
Informing	r = 0.038	p = 0.812	r = –0.174	p = 0.271
Reflecting	r = 0.224	p = 0.155	r = 0.333	p = 0.031*
Assigning tasks	r = –0.058	p = 0.717	r = 0.057	p = 0.720
Chatting	r = 0.351	p = 0.023*	r = 0.145	p = 0.359

*$p < 0.05$

Individual differences related to learning outcomes

To observe how individual differences are related to the web-based learning outcomes, correlation analyses were conducted to determine the relationship between learning outcomes (according to students' final score) and variables in individual differences identified from the study, including gender, cognitive styles, LASSI measurement, reactions toward instructional content and online interaction, and frequency counts of online action and socialization gathered from students' postings. As can be seen, students' learning outcomes were moderately correlated with students' online actions (r = 0.484, p = 0.001) and highly correlated with online socialization (r = 0.711, p = 0.000) (Table 12). Students with high involvement in online interaction performed significantly better than the less-involved students in mid-term exam, final group report, and final score ($p < 0.001$) (Table 13).

Table 12 Correlation Analyses between Learning Outcomes and Various Variables

Correlation /w outcomes	FI/FD	Gender	LASSI	Reactions toward content	Reactions toward online interactions	Online actions	Online socialization
r =	0.004	–0.063	–0.117	0.117	0.042	0.711	0.484
p =	0.982	0.693	0.459	0.460	0.792	0.000***	0.001**

** $p < 0.01$, *** $p < 0.001$

Table 13 Comparison of Learning Outcomes between Different Levels of Involvement

Level of involvement	Mean	SD	ANOVA Test
Low	73.69	4.46	$F(1, 40) = 29.124$, $p = 0.000$ ***
High	80.96	4.21	

*** $p < 0.001$

Correlations between LASSI constructs and students' online actions and reactions were also conducted. It was observed that any of the LASSI constructs correlated insignificantly with online action ($p > 0.05$) and online socialization ($p > 0.05$). However, two constructs "Selecting main ideas" and "Problem solving" were positively correlated with students' reactions toward the online content and the online interaction" ($p < 0.05$) (Table 14).

Table 14 Correlation Analyses between LASSI Constructs and Learning Reactions

LASSI construct	Reactions toward online content	Reactions toward online interaction
Attitude	r = –0.196; p = 0.214	r = –0.136; p = 0.390
Motive	r = 0.143; p = 0.367	r = 0.163; p = 0.302
Time management	r = 0.134; p = 0.398	r = 0.258; p = 0.099
Anxiety	r = 0.117; p = 0.461	r = 0.259; p = 0.098
Concentration	r = –0.046; p = 0.772	r = 0.125; p = 0.429
Information processing	r = 0.148; p = 0.348	r = 0.184; p = 0.243
Selecting main ideas	r = 0.322; p = 0.038*	r = 0.324; p = 0.036*
Study aids	r = 0.179; p = 0.258	r = 0.103; p = 0.517
Self-testing & reviewing	r = 0.158; p = 0.318	r = 0.083; p = 0.083
Test strategies	r = –0.065; p = 0.681	r = 0.077; p = 0.629
Problem solving	r = 0.504; p = 0.001**	r = 0.457; p = 0.002**

* $p < 0.05$; **$p < 0.01$

Discussion

In web-based learning cases, students' actions in achieving learning tasks reveal patterns in their interaction with peers. From the web-based learning context, the interactive discussion forum served as a purposeful, self-regulatory learning tool. Actions observed from the discussion forum were identified as "Referencing information", "Experience sharing", "Organizing", and "Socializing". Specifically, several types of social communication were also observed, including "Requesting information", "Reminding", "Informing", "Reflecting", "Assigning tasks", and "Chatting". From the cognitive aspect of learning, these actions reflected in-

dividuals' processes of interpretations, analyses, evaluations, and communications for knowledge construction. Since meaningful learning requires students bring some experience or knowledge to a situation (Kostovich et al., 2007), actions encouraging thinking and reflecting processes in the study might ignite the desire for new knowledge acquisition.

Gender differences in their social interactions and learning styles have been identified (e.g. Beck et al., 2007; Wehrwein et al., 2007), and research on gender participation in online discussions has also indicated that there are some notable differences in the ways men and women interact online (Herring, 2003; von Prummer, 2004). In the analysis of learners' characteristics, variation in task situations should be taken into consideration. In this research, students' postings on discussion tallied for gender comparison revealed significant correlation for "Experience sharing" ($p < 0.001$) in online actions and "Chatting" ($p < 0.05$) in socialization. Since in the web-based learning context, online interaction is mandatory, both males and females were engaged in the learning tasks to fulfill course requirements, however, their actions for interactions varied. The significant corrections observed between gender and online actions or socialization might be due to their online interactive preferences in expressing their sense of community (Rovai & Baker, 2005). However, further study is needed to confirm the research results.

In studying differences of field dependence, some research has indicated that tendencies of field dependence can affect both classroom success and grade achievement (Williamson & Watson, 2007). For example, Luk (1998) found that FD students struggled with learning through distance education delivery systems, revealing that they were at a disadvantage in distant learning. Kahtz and Kling (1999) found similar results when testing students who participated in computer-assisted instruction (CAI) courses. Different from aforementioned assertion and research results, this study showed insignificant relationship between field dependence and learning achievement in the web-based learning context ($p > 0.05$). Similar findings were also concluded by Freeman and Tijerina (2000) and Ramprogus (1988) in studying relationship between learning styles and learning outcomes. From the online discussion, none of the online action significantly correlated with cognitive style. However, students' socialization in "Reminding" and "Reflecting" correlated significantly with cognitive style ($p < 0.05$). Since the designed web-based learning is meant to cater for students with diverse abilities and learning styles, when multiple means of representation, expression, and engagement are well considered, students with diverse characteristics might all benefit from the web-based learning context (Burgstahler, 2007; Williamson & Watson, 2007).

In spite of the individual differences in gender, cognitive styles, and traditional use of learning strategies (LASSI), students' learning outcome correlated insignificantly with these variables ($p > 0.05$). According to Chen & Macredie (2002), individual differences reflect the need of implementation in the use of instructional strategies. Since specific instructional adaptations were made to help students gain self-awareness and self-direction in web-based learning, all students achieved their learning objectives. In this study, students' learning outcomes correlated significantly with their online actions ($r = 0.711$) and socialization ($r = 0.484$) reflected the impact of involvement as the key learner-characteristic factor that influenced learning. Correlation analyses of various LASSI constructs with students' reactions revealed that the strategies used for selecting main ideas and problem-solving were related to students' reactions toward online learning content and online interaction ($p < 0.05$). This implies that students' attitude toward learning was related to their use of strategies in problem-solving and selecting main ideas from the task-oriented web-based learning.

The results of the study also show that students with high level of involvement achieved better learning outcomes than those with low level of involvement ($p < 0.0001$). From this finding, individual differences in task-involvement reflected a contextual feature in influencing online learning outcomes. The potential of the interactive process in the learning context encouraged the development of student-centered learning and fostered a more in-depth approach to learning. Effective administration of students' learning and social interaction helps students achieve their learning tasks (Muilenburg & Berge, 2001). The results of this study reveal positive impact of students' participation and involvement in online activities on learning.

Conclusion

The purpose of this research was to examine the relationship between online learning outcomes with variables in individual differences, such as gender, cognitive style, and study tactic. Both qualitative and quantitative research approaches were used. During the students' learning process, several types of actions were identified. The actions reflected students' processes of interpretations, analyses, evaluations, and communications for knowledge construction and meaningful learning. Students with individual differences learned equally well from the web-based learning context. The only variable that influenced course outcomes in learning for the online course was students' level of involvement and frequency of actions performed in the online interactive forum. Students with high involvement performed better than those with low involvement in online interaction. In

this study, e-portfolio served as a means to study students' characteristics in performing learning tasks. The findings of this study indicated that neither gender nor cognitive style preference played a role in students' learning achievement. However, differences were found from the process of interaction. In analyzing students' characteristics in online actions, differences in gender were observed in chatting and experience sharing, and differences in cognitive styles were observed in reminding, reflecting, and experience sharing. Further study to confirm these study results is needed. The findings of this research support the conclusion that encouraging students to participate actively in online interaction can be effective for students with various kinds of characteristics. However, to advance the study on the relationships between learner characteristics and teaching strategies, further development and validation of the instruments used for measuring individual differences relevant to online learning context are needed.

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線上學習中電腦媒介溝通之個別差異

林麗娟

教授
輔仁大學圖書資訊學系
E-mail: lins1005@mail.fju.edu.tw

摘要

線上學習最重要的關鍵在於學生能夠藉由線上學習的環境，達成學生與學生之間的互動、學生與教師之間的互動，以及在這些互動過程中所產生協同學習的結果。然而學生在線上討論區參與討論互動的特質可能與學生本身的特質有關。學生參與線上互動的程度，與學習的關係值得進一步分析。本研究進行過程主要以線上學習課程「電腦人因」為例，蒐集學生線上學習討論的資料。在這個課程中，為了助長學生自導式的學習，透過課堂任務的指定，以及專題研究的完成，鼓勵學生進行必要的線上互動。本研究主要的重點在於觀察(一)學生個別差異在課業相關之線上討論參與線行動表現的關係，以及(二)線上活動參與與學習表現的關係。配合質性與量化的方式，搜集學生學習過程與成果資料，並針對學生所發佈的文字資料進行歸類分析，然後依據歸類結果進行數量的統計。其中各種個別差異的指標，包括性別、認知型態、學生讀書學習策略。學習過程中，教學上也依據學生特質做了對應的調整，以因應學生學習需求。除了線上學習紀錄之外，研究並蒐集了學生的學習檔案、學習作業與專題成果，以便於進一步的分析。研究結果歸納學生個別差異與線上表現的特定項目具有顯著相關。而學生線上學習參與的程度不同，學習表現結果亦具顯著差異($p<0.0001$)。

關鍵詞：電腦為媒介之溝通，網路為本互動，網路為本討論，個別差異，高等教育