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The Relationships among College Students' Use of and Attitudes toward CMS's Interactive Functions and Their Online Learning Performance

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Abstract: For over a decade, online courses have grown in higher education on both a percentage and numeric basis. With the increase of online learning in higher education, there are increasing numbers of discussions about factors concerning successful online learning or students' achievement. This study examines the relationships among learners' use of course management system (CMS) interactive functions, attitudes toward CMS, and online learning performance. Data was drawn from 407 undergraduate students who enrolled in a general education online course from three universities in Taiwan. The results suggest that a relationship between learners' attitudes toward CMS and use of CMS interactive functions, but not with online learning performance. In addition, the results indicated that learners' use of learner-self and learner-instructor/learner interactive functions are related to online discussion participation scores, and learners' use of learner-content interactive functions is related to exam scores. Implications and future research directions are provided and discussed in an integral manner.

Keywords: Interactivity, interactive functions, online course, online learning performance

1. Introduction

Students' interaction is always an indispensable and fundamental component for their knowledge acquisition and cognitive development in traditional face-to-face learning settings (Song & McNary, 2011). As online learning becomes more and more popular in today's higher education, interaction remains an important practical as well as a research issue. In the earlier distance education context, Moore (1989) has proposed a three-dimensional framework that characterized interaction as learner to content, learner to instructor, and learner to learner. After the framework was proposed, Hillman, Willis and Gunawardena (1994) suggested a fourth dimension that characterized interaction as learner to interface. Later, Soo and Bonk (1998) mentioned that learner-self interaction should also be categorized into dimensions of interaction.

Since most of the online learning setting usually has no regular daily or weekly face-to-face encounters, a course management system (CMS), such as Moodle or Black Board, is usually adopted to provide all dimensions' interactions such as delivering and managing online courses materials/activities and students' learning progress (Malikowski, 2008; West, Waddoups, & Graham, 2007). Therefore, whether CMSs provide sufficient and effective interactive functions that facilitate students' interactions and learning has also become an important research issue (Chou, Peng, & Chang, 2010). Some studies (e.g., Chou et al., 2010; Kiousis, 2002; Thorson & Rodgers, 2006) indicated that learners' perceptions of interactivity are related to the overall online learning environment and learners' engagement. Other researchers proposed that perceived interactivity is a strong predictor of learners' attitudes toward a website. For example, Liaw (2008) investigated the relationship among learners' satisfaction, behavioral intentions, and the effectiveness of the

Blackboard e-learning system. The results showed that both learners' perceived usefulness and perceived satisfaction affected their behavioral intention to use such e-learning systems.

Moreover, a few studies have been conducted to examine the relationships between learners' behaviors in CMS and their learning performances. For example, Proske, Narciss and Körndle (2007) found that the use of interactive functions indeed improved learners' achievements. In other words, students' use of learning tools, such as marking and note-taking, were significantly correlated with their learning achievement. Zimmerman (2012) also examined the relationship between learners' interaction with learning content and their course grades. The result indicated that the more time learners spent on interacting with learning content, the higher grades they gained. However, the above-mentioned studies seemed to focus on only one dimension of the interaction (e.g., learner-content interaction) or limited interactive functions (e.g., interface-related functions), thus lacked the coverage of other interactive dimensions or functions. Furthermore, these studies used the course final, composite grade as the only indicator for learners' performance and thus neglected the other possible indicators (e.g., performances of online discussion or group project).

In response to these lacks in the literature, the purpose of this study is to examine the relationships among learners' self-reposted use of multifaceted interactive functions, their attitudes toward CMS, and their online learning performance (exams, group project, and online discussion). The study adopted a classification of five types of interaction proposed by Moore (1989), Hillman et al. (1994) and Soo and Bonk (1998), and the related dimensions of interactive functions for system design provided by Chou (2003) and Chou et al. (2010), that is, learner-self, learner-content, learner-interface, learner-learner, and learner-instructor. To assess learners' use of interactive functions and attitudes, this study developed a survey to collect quantitative data. The research questions here are as follows:

- How is learners' self-reported use of CMS interactive functions?
- What are learners' attitudes toward CMS?
- What are the relationships among learners' use of the CMS's interactive functions, their attitudes toward CMS, and their different online learning performance?

2. Literature Review

2.1 Types of Interaction and interactive functions of CMS

Moore (1989) was the first to identify three interactive relationships associated with a non-face-to-face learning environment: learner-content interaction, learner-instructor interaction, and learner-learner interaction. Later, Hillman, Willis and Gunawardena (1994) argued that Moore's three interactive relationships did not take account of interactions between learners and the technologies that support instruction and content in such learning, and suggested a fourth type: learner-interface interaction.

In addition, Soo and Bonk (1998) thought learners should develop ability to self-regulate in the process of learning; therefore, they suggested the learner-self interaction as the fifth dimension of interactive relationships. On the basis of the above studies, this study adopted five interaction types in a CMS-based online learning environment, and considered that all CMS's functions are designed to carry out the need for various interactions for learning. However, since CMS's functions for learner-instructor and learner-learner interactions are largely overlapped, we combined the leaner-instructor dimension and the learner-learner dimension to the new dimension named as learner-instructor/learner interaction. In other words, this study had finally categorized all CMS's interactive functions into four interaction dimensions:

- Learner-self interaction: Leaners can monitor and reflect their learning in learning process by using CMS functions (Soo & Bonk, 1998), such as Grade-status tracking, Examination-status tracking, etc.
- Learner-interface interaction: Learners can interact with some form of technology medium as part of the course requirements. In other words, learners can access desired information with a user-friendly interface in a CMS (Hillman et al., 1994; Peng, Chou, & Chang, 2008) by using the function such as System update or System announcement.

- Learner-content interaction: Learners can acquire multimedia learning contents from a CMS (Moore, 1989; Su, Bonk, Magjuka, Liu, & Lee, 2005) by using the functions of Study guidance, FAQs.
- Learner-learner/instructor interaction: Learners can communicate with instructors/other learners and peers synchronously (online meeting, online chat rooms) and asynchronously (e-mail, discussion boards) (Kearsely, 1995; Zimmerman, 2012) by using functions of Assignment handling, Discussion board, and Email.

2.2 Attitudes toward CMSs

Learners' attitudes toward the CMS are critical to determine whether they will accept or continue to use such a learning system (Sun & Hsu, 2013). For instance, Liaw's study (2008) investigating CMS use by 424 Taiwan students found that both learners' perceived usefulness and perceived satisfaction affect their behavioral intention to use such e-learning systems. In addition, learners' perceptions of e-learning effectiveness might be influenced by interactive learning activities, method of instruction, and e-learning system quality. Past research has also indicated that a higher level of interactivity is more associated with enhanced positive attitudes (Johnson, Hornik, & Salas, 2008; Jung, Choi, Lim, & Leem, 2002; Kettanurak, Ramamurthy, & Haseman, 2001). Thorson and Rodgers (2006) found that learners' perceptions of interactivity influenced their evaluations of a website. Chou et al. (2010) indicated that the higher students perceived the CMS's interactivity, the more positive perceptions of CMS they had used.

Consequently, learners' perceptions of interactivity are affected by interactive features or functions, which are also relevant to their attitudes toward CMSs. However, thus far we have only found more studies with regard to attitudes toward CMSs, there were a few researches discussing about the relationship among learners' attitudes toward CMSs, their use of interactive functions in such CMSs, and their online learning performances. Therefore, the relationship among the three elements (attitude, use, and performance) has become the focus of the present study.

3. Method

3.1 Participants

The participants consisted of 407 undergraduate students enrolled in the same general education online course from three universities in Taiwan. These course materials were delivered via an e-Campus learning management system III (the e3-system). The sample included 260 males and 147 females. Thirty-one (7.6%) participants were freshmen, 191 (46.9%) were sophomores, 140 (34.4%) were juniors and 45 (11.1%) were seniors. About participants' experiences of using the e3-system, there were 114 (28%) participants using the e3-system under one year, 213 (52.3%) for two to three years, and 78 (19.2%) for four to five years (see Table 1).

Regarding students self-reported use, 168 (41.3%) participants logged in the e3-system several times a week, 126 (31.0%) several times a day, 61 (15%) once a day, 46 (11.3%) once a week, and only 6 (1.5%) once every two weeks. Moreover, about 89 (21.9%) participants reported that they spent 11 to 20 minutes staying in the e3-system per log-in and 85 (20.9%) participants spent 21 to 30 minutes staying in the e3-system then logged out (see Table 1).

Table 1: Students demographics and self-reported use of the e3 system (N=407).

Measure and items		**Frequency**	**Percentage (%)**
Gender	Male	260	63.9
	Female	147	36.1
Grade	Freshman	31	7.6
	Sophomore	191	46.9
	Junior	140	34.4
	Senior	45	11.1

Experiences of using the e3-system	under 1 year	114	28.0
	2-3 years	213	52.3
	4-5 years	78	19.2
Frequency of logging in the e3-system	Once two weeks	6	1.5
	Once a week	46	11.3
	Several times a week	168	41.3
	Once a day	61	15.0
	Several times a day	126	31.0
Average length of staying in the e3-system	Under 10 mins	42	10.3
	11-20 mins	89	21.9
	21-30 mins	85	20.9
	31-40 mins	38	9.3
	41-50 mins	19	4.7
	51 mins -1 hr	33	8.1
	1-1.5 hr	37	9.1
	1.5-2hr	43	10.6
	Over 2hr	20	4.9

3.2 Instruments

To meet the purposes of this study, we used the questionnaire to investigate students' use of the e3-system interaction functions and their attitudes toward the e3-system.

The questionnaire had three parts. The first part asked for students' demographic information (gender, grade, using the e3-system experience), as reported above. The second part asked for students' self-reported use of the e3-system interactive functions. The reason we used the self-reported questionnaire instead of actual logging data was that the e3-system did not provide detailed records of all interactive functions which learners have used. The questionnaire consisted of 19 items based on four interaction styles: learner-self interaction, learner-interface interaction, learner-content interaction, and learner-instructor/learner interaction. Each item referred to a particular function (such as Assignment completion tracking) in one interaction style (such as Learner-self interaction) provided by the e3-system and used a six-point Likert rating format: 1. never; 2. only once; 3. occasionally; 4. regularly; 5. frequently; 6. always. Having a higher score indicated that students had higher frequency to use these functions.

The third part of the questionnaire asked for learners' attitudes toward the e3-system. This scale consisted of four items using a five-point Likert rating format: 1. very low; 2. low; 3. normal; 4. high; 5. very high. Having a higher score indicated that students had a positive attitude toward the e3-system. In other words, the higher scores students got, the more positive attitudes they had toward the e3-system.

3.3 Data Collection

In order to collect data, researchers handed out questionnaires along with their midterm in the classroom. Students on a voluntary basis were asked to provide their identification numbers to the questionnaire in order to match up their scores afterwards. The data was gathered for four semesters from fall 2010 to spring 2012. A total of 541 questionnaires were given during the midterm. After comparing to each student's questionnaires to their grades, only 407 responses were usable for further analysis.

In addition, this study used three scores for students' three types of online learning performance: group project, midterm/final exam, and online discussion performance. The following are the details about the three scores:

- Group project performance score: Two instructors and three teaching assistants assessed students' group projects based on a set of criteria, including consistency, accuracy, completeness, creativity, and organization.

- Midterm/final exam score: In order to evaluate students' performance in this online course, a midterm exam was held in the middle of the semester and a final exam at the end of semester. Each student needed to take the paper-and-pencil exams in the classroom.
- Online discussion performance score: The measurement of online discussion performance was based on the number and quality of messages posted. Each student was required to have a minimum of two postings per week including responding to the discussion issues posted by the instructors and their peers; moreover, each student had to post two new messages for peer discussion each semester. Quality of messages was scored by two instructors and three teaching assistants based on clarity and reasonableness in their postings.

All students had composite semester final grade points that ranged from 32 to 97 (on a 100-point basis), with a mean of 76.75 and a standard deviation of 13.51.

4. Results

4.1 Use of CMS Interactive Functions

Students self-reported their use of the e3-system's interactive functions in four dimensions, as shown in Table 2.

Table 2: Students' self-reported use of the e3-system interactive functions.

The use of functions		**Used (%)**	**Mean***	**S.D.**
Learner-self interaction			**3.88**	**.859**
1	Assignment-completion tracking	96.1	4.52	1.124
2	Task-list	92.6	4.18	1.332
3	Grade-status tracking	88.2	3.77	1.371
4	Presentation-status tracking	87.2	3.71	1.398
5	Examination-status tracking	83.3	3.69	1.526
6	Login-status tracking	82.6	3.44	1.457
7	Materials-viewed tracking	81.8	3.80	1.533
Learner-interface interaction			**4.33**	**1.085**
8	System announcement	95.3	4.78	1.182
9	Subscription to course-related information	87.2	4.26	1.482
10	System update	83.0	3.96	1.590
Learner-content interaction			**3.98**	**1.009**
11	Study guidance	92.6	4.12	1.307
12	Multimedia presentation	91.4	4.15	1.295
13	Learner contributing to learning materials	86.5	3.84	1.396
14	FAQs about contents	85.7	3.80	1.428
Learner-instructor/learner interaction			**3.94**	**.784**
15	Assignment handling	98.0	4.76	.935
16	Discussion board	95.3	4.59	1.173
17	Online survey	89.9	3.64	1.193
18	Class roster	84.5	3.23	1.311
19	Email	83.3	3.45	1.476

*Based on a 6-point Likert scale: 1＝never, 2＝only once, 3＝occasionally, 4＝regularly, 5＝frequently, 6＝always

The means for use of the e3-system's interactive functions for the four dimensions were 3.88, 4.33, 3.98, and 3.94, respectively. In other words, on average, students used the e3-system's interactive functions occasionally to frequently. To be more precisely, in the Learner-self interaction dimension, 96.1% of the students had used the Assignment-completion tracking function, 92.6% had used the Task-list function, while 81.8% of the students had used the Materials-viewed tracking

function. In the Learner-interface interaction dimension, the most used functions are System announcement (95.3%) and Subscription to the course-related information (87.2%).

In the Learner-content interaction dimension, 85.7% of the students had used the FAQs about course function (such as homework requirement and due-dates) and 92.6% of the students had used the Study guide function (such as course objectives and weekly schedule). Finally, in the Learner-instructor/learner interaction dimension, the functions students used most are Assignment handling (98.0%), Discussion board (95.3%), Online survey (89.9%), and the least-used function is Email (83.3%) for contacting instructors or with other learners.

4.2 Attitudes toward CMS—the e3-system

Students were surveyed regarding their attitudes toward the e3-system with four items: the overall value of the e3-system's collection of the interactive functions, the overall value of the e3-system's interactivity, the usefulness of the e3-system for online learning, and the preference of the e3-system for online learning.

As shown in Table 3, 49.1% of the students' overall value of the e3-system's collection of the interactive functions were high or very high, 43.5% of the students' evaluation were about average. Additionally, more than 70% of the students' attitudes toward the e3-system interactivity were high or very high, and only 2.2% of the students' attitudes were low or very low.

Table 3: Students' attitudes toward the e3-system.

	very low	low	normal	high	very high	Mean*	S.D.
	n (%)						
Attitudes toward the e3-system						**3.71**	**.581**
The overall value of the e3-system collection of the interactive functions	3 (0.7)	27 (6.6)	177 (43.5)	171 (42.0)	29 (7.1)	3.48	.755
The overall value of the e3-system interactivity	1 (0.2)	8 (2.0)	112 (27.5)	240 (59.0)	46 (11.3)	3.79	.668
The usefulness of the e3-system for online learning	2 (0.5)	9 (2.2)	93 (22.9)	244 (60.0)	59 (14.5)	3.86	.698
The preference of the e3-system for online learning	0 (0.0)	18 (4.4)	128 (31.4)	208 (51.1)	53 (13.0)	3.73	.741

*Based on a 5-point Likert scale: 1＝very low, 2＝low, 3＝normal, 4＝high, 5＝very high

Also shown in Table 3, more than 70% of the students indicated that the usefulness of the e3-system for online learning were high or very high while 25.6% of the students' considered average, low, or very low. Moreover, 64.1% of the students indicated that their preference of the e3-system for online learning were high or very high, 31.4% indicated average; only 4.4% of the students' preference were low, and no one's evaluation was very low.

4.3 Correlation Analysis

A summary of correlation analysis among students' attitudes of the e3-system, use of the e3-system's interactive functions in four dimensions, and their three types of online learning performance were presented in Table 4.

Table 4: Correlation of variables (N=407).

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. Online discussion performance score	1							
2. Midterm/final exam score	.597***	1						

Variable	1	2	3	4	5	6	7	8
3. Group project performance score	.527***	.445***	1					
4. Attitudes toward the e3-system	.049	-.046	.032	1				
5. Use of Learner-self interactive functions	.110*	-.042	-.004	.332***	1			
6. Use of Learner-interface interactive functions	.077	.009	.030	.271***	.334***	1		
7. Use of Learner-content interactive functions	.003	-.108*	-.056	.274***	.469***	.361***	1	
8. Use of Learner-instructor/ learner interactive functions	.181***	.083	.081	.220***	.340***	.379***	.358***	1

A strong relationship appeared among attitudes of the e3-system and use of the e3-system interactive functions. The positive correlation was found in the following combinations: attitudes toward the e3-system and the use of Learner-self interactive functions (r=.332, p<.001), the use of Learner-interface interactive functions (r=.271, p<.001), the use of Learner-content interactive functions (r=.274, p<.001), and the use of Learner-instructor/learner interactive functions (r=.220, p<.001). However, the relationship between attitudes of the e3-system and online learning performance was not found. In other words, students' attitudes toward the e3-system were not related to their online learning performance, but were related to their use of the e3-system's interactive functions.

In addition, the results showed that online discussion performance score were related to use of Learner-self interactive functions (r=.110, p<.05) and Learner-instructor/learner interactive functions (r=.181, p<.001), but were not related to the use of Learner-interface interactive functions and Learner-content interactive functions. The results also showed that midterm/final exam score were negatively related to the use of Learner-content interactive functions (r=-.108, p<.05) and were not related to students' use of interactive functions in the Learner-self, Learner-interface, and Learner-instructor/learner dimensions. As shown in Table 4, students' group project performance score was not related to any dimensions of the e3-system's interactive functions that students have used.

5. Discussion

The primary purpose of this study was to examine the relationships among learners' self-reported use of a CMS (the e3-system) interactive function, attitudes toward such CMS (the e3-system), and their three types of actual online learning performance. The findings were discussed below.

5.1 Students' use of CMS—the e3-system

In this study, the results indicated that students' self-reported use frequency of interactive functions that the e3-system has provided was between "occasionally" and "regularly". Across the four interaction dimensions, on an average, students reported that they have used the Learner-interface interactive functions more frequently than the functions in the Learner-self, Learner-instructor/learner, or Learner-content dimensions. It is possible that only three functions were listed in this dimension while more functions (4-7) were listed in other dimensions with a larger variance in percentages of students' indication of their usage.

Nevertheless, all 19 interactive functions provided by the e3-system were used by more than eighty percent of the surveyed students. When investigating which functions students have used most, it is found that the most-used two interactive functions are all related to students' assignment: 98% of

students have almost frequently used the Assignment handling function in the Learner-self dimension, and 96.1% have almost frequently used the Assignment-completion tracking function in the Learner-instructor/learner dimension. The results indicated that students most cared about their assignment; they not only had turned in their assignments through the e3-system as required, but also regularly checked whether they had successfully done so (the completion status) by using such function (the completion-status tracking). The next most-used functions are Discussion board (95.3%), System announcement (95.3%), Task list (92.6%), and Multimedia presentation (91.4%). Except for the System announcement function which sends system maintenance or data backup-related news, other functions are directly related to course requirements such as posting in the discussion board, checking the number and status of learning tasks, and viewing the multimedia content. Across the 19 interactive functions, the least-used functions are Materials-viewed tracking (81.6%), and Login-status tracking (82.6%) in the Learner-self dimension. Although these two tracking-related functions were designed to help students monitor their learning progress, it seems that the use of them was not directly related to the course performance, therefore, relatively less students reported to have used them.

5.2 Students' attitudes toward CMS—the e3-system

With regard to students' attitudes toward the e3-system, we found that most students had a generally positive attitude toward the e3-system. According to the four items, most students reported that their evaluation of the interactive functions of the e3-system and overall interactivity of the e3-system were between "normal" and "high". A possible reason is that students used these interactive functions that the e3-system has provided to fulfill the course requirements. For example, they used the Discussion board to post messages and discuss the topics with peers or used the Assignment handling function to upload their reports or homework. Therefore, students' attitudes toward the e3-system's interactive functions and overall interactivity of the e3-system were positive.

In addition, most students reported that they considered the usefulness and preference of the e3-system between "normal" and "high". It is possible that because the entire online course used the e3-system to be a main learning platform and all learning activities were organized in the e3-system, therefore, students had no other choice but logged into the system to learn. It also seemed that the e3-system as a CMS functions well to serve students' whole class learning.

5.3 The relationships among use, attitudes, and online learning performance

What is the relationship between students' use and their attitudes toward the CMS (the e3-system)? The results indicated that students' self-reported use of the interactive functions in the four dimensions was significantly correlated with their attitudes toward the e3-system. In other words, the more interactive functions students have used, the higher they evaluated the e3-system. Or, as they used the e3-system more, they seemed to appreciate it more. It is possible that the e3-system is the only channel to help students complete the course requirements, and the functions of the e3-system indeed fulfill all their needs for the course.

However, it is somewhat surprisingly, in contrast to previous studies, that our findings showed no significant relation between students' attitudes toward the e3-system and their online learning performance. This study used four items to assess learners' attitudes toward the e3-system (the overall value of the e3-system collection of the interactive functions, the overall value of the e3-system interactivity, the usefulness of the e3-system for online learning, and their preference of the e3-system for online learning), and the composite attitude scores were not significantly related to either learners' group project performance score, midterm/final exam score, or online discussion performance score. Past studies (e.g., Kettanurak et al., 2001; Sun & Hsu, 2013) all showed significant result that students' perceived higher interactivity would enhance their learning achievement. One explanation for this inconsistent result may be that students used the e3-system just to fulfill course requirements, such as handling assignments, viewing materials or posting on discussion board. Thus, whether the e3-system is useful or beneficial, their online learning performance may not be influenced. Another possible reason is that the e3-system and its interactive functions are minor or unimportant factors to contribute to students' all types of learning achievement. In other words, other factors such as

students' motivations, their hard-working degrees, and so on, which were not covered in the current study, may be more important to affect their learning achievement.

Moreover, this study also found that learners' use of the e3-system interactive functions was not totally related to their online learning performance. In specific, learners' online discussion performance score was related to the use of Learner-self interactive functions and Learner-instructor/learner interactive functions, but not related to the use of Learner-interface and Learner-content interactive functions. It is very possible that students' posting requirement was not kept reminded by the instructors so that they had to be more responsive and use the Learner-self interactive functions (such as Task-list, Assignment-completion tracking) and Learner-instructor/learner interactive functions (such as Discussion board, Email) more frequently to fulfill such course requirement; thus their online discussion performance score might be higher.

In addition, more surprisingly, students' midterm/final exam score was not related to their use of Learner-self, Learner-interface, and Learner-instructor/learner interactive functions, but was significantly negatively related to the use of Learner-content interactive functions. One possible explanation is that the Learner-content interaction dimension includes four interactive functions (Study guidance, Multimedia presentation, Learner-contributing to learning materials, and FAQs about contents). Not every function (such as Study guidance, Learner-contribution to learning materials) is directly related to students' exam performance. In order to check whether students' use of a particular function—Multimedia presentation—was related to their exam scores, further statistics was conducted and found that, however, students' use of such function was not related to their exam scores ($r=.077$, $p=.119$). One possible explanation is that students only reported about their frequency of using this function, not the length of each use. In other words, other factors such as the length of each use or their attention degrees to the multimedia presentation, to name a few, may contribute to the exam scores. Definitely this explanation need further research to prove.

Finally, students' self-reported use of the interactive functions, in any dimension, was not related to their group project performance scores. It means that the e3-system's interactive functions may not directly help enhance their group project performance. It is possible that students conducted their group project by other communication channels such as face-to-face meeting; they may not complete each assignment merely through the e3-system.

6. Conclusion

This research was motivated by the desire to gain a better understanding the relationships among learners' use of CMS interactive functions, their attitudes toward CMS, and their online learning performance. First of all, this study found that students have used most of the functions that our CMS has provided, and they used them occasionally or regularly. Students seemed to care about their assignments most, therefore, they used the related interactive functions most to handle and check their assignment turn-ins. Secondly, students seem to have positive attitudes toward the CMS in general and its functions in particular. It is noted that, although this study suggested that learners' use of different CMS interactive functions were related to their overall attitudes toward such CMS, the attitudes did not contribute to their various types of learning performance. Nevertheless, using some interactive functions in the Learner-self interaction and the Learner-instructor/leaner interaction may contribute to students' overall online discussion performance.

To follow up the findings of the current study, we proposed several research extensions. First, the use of CMS interactive functions was self-reported, further study can be conducted on students' actual participations in an online course and its relationship with their self-reported use of CMS functions, their attitudes toward CMS, and their learning performance. The actual participation could be measured by the logging records of all interactive functions learners have used. In this case, we can better understand the relationship among learners' use of and attitudes toward CMS, and their various performances.

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