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A Three Year Analysis of CMS Use in Resident University Courses

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Abstract

American universities have adopted course management systems (CMSs) at levels that are unprecedented in learning technology. Researchers have investigated CMS use for a few reasons. First, they are interested in learning what universities are getting from the large investment into these systems. Second, there are so many features in a CMS that researchers are curious which features are used most. And third, identifying the most-used features can lead to further research into how these features can be used more effectively. Current research has provided helpful information, but it typically lacks statistical analysis, performance-based data, and longitudinal data. The study described here built on previous research by addressing these issues. CMS use at one university was studied from 2005 – 2007. Results showed that few significant changes in CMS use occurred in this time, with CMSs primarily used to transmit information to students and occasionally used for student interaction. Recommendations for further research are included.

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Introduction

Course management systems (CMSs), such as Blackboard, Desire2Learn, or Moodle, have become one of the most common computer systems ever adopted at American universities (Allen, Seaman, & Sloan, 2007; Falvo & Johnson, 2005; Saettler, 1990). In addition to being a commonly adopted system, CMSs have also become part of other university systems, such as those involved with student services, teaching support, and technical support (Black, Beck, Dawson, Jinks, & DiPietro, 2007; Morgan, 2003; Regan & Walcher, 2005). Like any mainstream system, there has been a healthy degree of criticism of CMSs (Clay, Wheeler, & Attwell, 2009), but current research indicates CMSs have been broadly adopted and will be part of university systems for the foreseeable future.

A common area of research has focused on how professors and students use a CMS, which will be described in detail later. This is a reasonable area to investigate because CMSs allow both groups to add information to the system. A general benefit of this research is that it begins to answer the question, "What are universities getting for their large investment in these systems?" Specific benefits of this research are similar to the benefits of a technology audit (Senft & Gallegos, 2009). By reviewing or auditing how any technical system is used, strengths and weaknesses can be identified. Then, efforts can be made to help more people benefit from the strengths and improvements can be sought for the weaknesses.

Another specific benefit of measuring how professors and students use a CMS involves the large number of features that are available, such as providing documents to students, online discussions, quizzes, surveys, and more. Then, there are features within these features. Presumably, some features are going to be used more than others. One effective area of research would start with the CMS features that are used most, identify variations of how these features can be used, and gather empirical data about how these variations compare for a specific learning goal. This is particularly important when considering that professors typically make their own decisions about how a CMS is used (Coates, James, & Baldwin, 2005; Morgan, 2003). Therefore, if researchers wish to improve how CMSs are used, it is reasonable to start with the features that are used most, especially since all CMS features have many technical and pedagogical options.

Literature Review

A few patterns have emerged in research focusing on CMS use. These patterns involve findings, data collection methods, duration of research, and how results are analyzed. Each will now be described, using a chronological sequence where possible.

Research Patterns: Common Findings

Research into CMS use became particularly active in 2003 and 2004 (Ansorge & Bendus, 2003; Dutton, Cheong, & Park, 2004; Morgan, 2003; Woods, Baker, & Hopper, 2004). A summary of this research (Malikowski, Thompson, & Theis, 2007) focused on professors' use of CMSs. This summary showed that about 75% of professors used a CMS to transmit files containing course content to students, such as a syllabus or class readings. This literally reflected a transmission model of learning, at least for CMS use. Other CMS features were used much less. About 30% of professors use a CMS for asynchronous discussions, and about 25% use a CMS for assessments, primarily for multiple choice quizzes or tests. CMS-based surveys were used by about 15% of professors, and other features were used by less than 5% of professors.

This research provided important insights into CMS use, but there were also concerns that CMS research focused too much on technical issues and not enough on learning issues (Coates et al., 2005; Morgan, 2003; Woods et al., 2004).

The summary mentioned in the previous paragraph (Malikowski et al., 2007) also proposed a model for CMS research. The model provided strategies to link research in CMS use to research into learning psychology, and successful "pre-Web" innovations with learning technology. The model proposed six categories of CMS features, which were most used by professors. These categories are: (1) transmit documents to students, such as a syllabus or assignment, (2) provide a grade book, (3) communicate asynchronously, (4) quiz students, (5) use a drop box to exchange files with students, and (6) survey students. Popular CMSs typically contain all these features, but the features are given different names, at least by default. For example, the feature to transmit documents to students is called "Course Documents" in Blackboard, and this same feature is called "Content" in Desire2Learn (Malikowski et al., 2007; Morgan, 2003). The model provided a standard set of terms for the most used CMS features. The model also contains a flowchart summarizing how professors are most likely to move among these categories and how established learning theories can be applied.

This CMS research model has been used to guide research by its authors (Malikowski, 2008; Malikowski & Theis, 2006; Malikowski, Thompson, & Theis, 2006) and others (Andrews, Bond, & Speller, 2009; Beer, Jones, & Clark, 2009; G. Smith, Heindel, & Torres-Ayala, 2008; Wilkie, In-Press). A general pattern in this research is that professors primarily use a CMS to transmit information to students, such as files or grades. Other CMS features, even the interactive features, are used by a small percentage of professors. In some cases, features are used more often by professors in one academic discipline than others (G. Smith et al., 2008). For example, professors teaching psychology are significantly more likely to use CMS quizzes than other professors, and professors teaching education are significantly more likely to use online discussions (Malikowski et al., 2006). Other specific patterns are difficult to identify, however, because of the diverse data gathering and analysis methods applied in CMS research.

Research Patterns: Common Methods

Other issues in CMS research have less to do with technology and more to do with methodology. One common method for gathering data about popular features is to ask people how they use a CMS, usually with a survey or interviews (Andrews et al., 2009; Ansorge & Bendus, 2003; Morgan, 2003; Woods et al., 2004). When the goal is to identify behaviors, such as which CMS features professors use, asking people about their behavior is less accurate than observing their behavior (Borg & Gall, 1989; J. L. Green, Camilli, & Elmore, 2006), because of how people perceive themselves and what they are comfortable telling a researcher.

Surveys are a relatively easy way to collect data, especially Web based surveys that automatically store data into a computer file and chart the results. Surveys also make it convenient to gather data from hundreds or thousands of people. In contrast, methods for observing CMS use are time-intensive and tedious. For example, one method for observing CMS use is to view the CMS Web site of several, possibly hundreds, of professors and count how often common features are used. This method is even more time-consuming when the number of features on each Web site are counted twice, to increase data accuracy. This degree of effort limits the number of participants in a study, typically to the low hundreds (Beer et al., 2009). However, this method has the benefit of increasing the accuracy of which features are used most.

A final data collection method worth considering is automated or computer based analysis, using Web server logs (Beer et al., 2009; Morgan, 2003). This method can be used to efficiently, and anonymously, analyze the work of hundreds of professors, thousands of their CMS Web sites, amounting to tens or hundreds of thousands of data points. Automated analysis also benefits from the large amount of work done with data mining (Castro, Vellido, Nebot, & Mugica, 2007; Romero, Ventura, & García, 2008).

However, automated analysis still has some respectable limits that need to be considered. One limit is that data mining continues to require a respectable degree of database structure and computer programming. A second limit is that automated analysis cannot identify CMS Web sites that should be removed from a data set. For example, professors typically have a chance to practice using a CMS before using it for a real course. Another example is a CMS Web site that was used for distance learning when the research question in a study focuses on CMS use in resident courses. Both of these examples would distort the findings of a research question involving CMS use in resident courses. The Web site(s) used for practice would likely show sporadic use of CMS features, and Web site(s) used for distance learning would likely show more breadth and depth in the use of features, than sites used for resident courses. A final challenge to consider with automated analysis involves the same technical challenges that many Web based applications face, such as difficulty when servers are moved or minor software bugs occur (Morgan, 2003). These challenges can be overcome with a careful research design, but when hundreds or thousands of CMS Web sites are included in a study, the challenges of automated analysis need to be carefully considered.

Research Patterns: Analyzing Results

A third pattern in CMS research involves how numeric results are analyzed. Typically, only descriptive statistics are provided, with little or no inferential statistics. Descriptive statistics are fine if the goal is to report basic information, such as the average age from participants in a study. However, inferential statistics are usually needed if the goal is to make comparisons among groups of people or variables, such as different behaviors among age groups, different use of CMS features, or differences over time. When descriptive statistics are used in this way, it is difficult to tell, with any precision, if results are due to chance or due to a specific teaching method (Borg & Gall, 1989; Cohen, 1988).

A possible explanation for not using inferential statistics is that the research is “Use-Inspired Research” (Hannafin, Orrill, Kim, & Kim, 2005, p. 12) as opposed to “Theory-Building Research” (Hannafin et al., 2005, p. 14). Theory-building research is more likely to use inferential statistics because they assist in generalizing findings from a sample to a general population. In contrast, these statistics could be less applicable for use-inspired research, since it focuses on a relatively small and local situation. In any case, the current state of CMS research focuses more on descriptive statistics than inferential statistics, possibly due to Use-Inspired research. Therefore, one way to build on, or balance, the current state of CMS research is to apply inferential statistics when making comparisons.

Research Patterns: Gather Data from a Single Term or Year

A final pattern in CMS research is a challenge faced in many areas of research. That is, most of the studies are conducted once, during a single term or year. This leads to a situation where it is difficult to tell if CMS use is really changing, even for a small number of popular

features. Longitudinal use can be inferred by comparing studies over time, conducted by different researchers. However, the degree of precision in this comparison is limited, due to how different researchers define the features they study, how they collect data, how they analyze the data, or a combination of these issues (Borg & Gall, 1989; J. L. Green et al., 2006). A longitudinal study coordinated by a single researcher, or research team, over a few years could resolve these challenges.

Some CMS researchers have conducted longitudinal studies. The longest study at the moment is being conducted by the Indicators Project (Beer et al., 2009). This group analyzed CMS usage from 2005 to 2009, using automated analysis on two CMSs. Reports from this project use the CMS research model previously described, so terms from that model apply, with one exception. The Indicators Project uses the term learning management system (LMS) instead of CMS, but for the sake of the current review, both terms have the same definition.

The Indicators project addressed a few issues and research questions, many of which are beyond the scope of the current analysis. An issue that is related involves their first research question, which was "Does LMS feature adoption differ over time and between LMS?" (Beer et al., 2009, p. 63). Unfortunately, no clear definition of adoption is reported. In other CMS research, adopting a feature has been operationally defined as using a feature once or using a feature enough times that the use is above the 25% quartile (Malikowski, 2008), of other professors using the feature. In any case, the Indicators Project showed the following, between 2005 and 2009:

- 60% to 100% of teaching staff used a CMS to transmit content.
- 25% to 99% of teaching staff used a CMS for class interactions, with a large increase in 2006.
- 15% to 65% of teaching staff used a CMS to evaluate students, with a moderate increase in 2006.
- 1% to 99% of teaching staff used a CMS to evaluate a course, with a large decrease in 2007.

The large decrease in 2007 occurred because a course evaluation feature, called a course barometer, was no longer a required part of CMS Web sites, in the courses studied. Staff involved with the Indicators project are forthright with the challenges they faced. For example, the conclusion of their report states "The purpose of this paper has been exploratory, to identify potentially interesting patterns that might indicate areas of future useful and fruitful analysis and research" (p. 69). A respectable challenge they face is that their data combines CMS use from two groups, which have notable differences. One group included students from traditional, resident courses. The other group included students from distance learning courses. A final challenge is that inferential statistics are not used to determine if there are differences between these types of students, specific years in the study, or other numerical data described in their report.

Another longitudinal study was conducted in the United Kingdom (UK) (Browne, Jenkins, & Walker, 2006). In the UK, CMSs are referred to as virtual learning environments (VLEs). In this study, higher education institutions were surveyed in 2001, 2003, and 2005. Some of the questions in this study were how many universities have adopted a VLE, how many students use the VLE, which workgroups support the VLE, which strategies encourage use, and how use has changed. Similar to other research, the statistical analysis is limited. In terms of VLE use, they found "…access to resources and course materials show the highest use." The

authors also described how VLEs were used to support collaborative work, peer support, and assessment, but they admit their data are unclear on these issues, when they report "Table 3 does not quantify use, and only indicates that such uses are taking place" (Browne et al., 2006, p. 181). Regarding barriers to adoption, the researchers found "Lack of money and time were the two most notable barriers, but lack of support staff, and lack of relevance to career development all scored highly" (Browne et al., 2006, p. 184).

Building on Previous Research

As described in the previous section, several studies have analyzed how CMSs are used. These studies provide useful information about what universities are getting for their investment in these systems, which features professors are most familiar with, and which issues need further research.

Four patterns of CMS research were reviewed. First, it has generally been found that CMSs are used to transmit information to students, but details of this use or details of the use of other features is lacking. Second, the most common data collection method is asking people how they use a CMS with surveys or interviews. The least common method is observing how CMSs are used, such as looking at specific CMS Web sites and counting which features were used. Third, current CMS research uses descriptive statistics more than inferential statistics when presenting quantitative data, even when groups of people or variables are compared. And fourth, few longitudinal studies have been conducted. The study described in the remainder of this report builds on previous research by gathering data based on observing how a CMS was used, analyzing the results with inferential statistics, and collecting data over three years. The research question for this study is "In resident university courses, did CMS use change significantly during 2005, 2006, and 2007?".

Methodology

Data were collected for this study during the spring semesters of 2005, 2006, and 2007, at a public, Midwestern university in the USA. The university had about 15,000 students during each year of the study. The CMS used at this university is Desire2Learn (D2L). CMS use was voluntary at this university, so professors had to request that a CMS Web site be created for their course(s). However, this Web site could be a copy of a CMS Web site that was used for a previously offered course, as long as the professor specified this copy be made.

In 2005, 81 professors participated in this study. In 2006, 158 professors participated, and in 2007, 155 professors participated. Since professors taught multiple courses, many used multiple CMS Web sites. On average, each professor used 3 CMS Web sites, SD=1.57. Only CMS Web sites used for resident courses were included in this study. Resident courses were considered to be traditional courses where students met weekly as a group with a professor. CMS Web sites were not included if they had no students, which was the case when a course was cancelled. In 2005, 152 CMS Web sites were analyzed. In 2006, 327 CMS Web sites were analyzed, and in 2007, 363 CMS Web sites were analyzed. Overall, 842 Web sites were analyzed during the three years of this study, in an attempt to get a comprehensive view of CMS use.

Data about CMS features was collected by a research team, typically two faculty members, two graduate students, and two undergraduate students. Specifically, data were collected by one team member viewing a CMS Web site and counting how often features were used, by using a paper form. The form contained the names of 30 features, such as number of

documents on a CMS Web site or the number of quiz questions available to students. To increase data accuracy, each CMS Web site was also analyzed by a second team member. Any discrepancies between the two forms were then identified and resolved by looking at the CMS Web site again.

The CMS research model previously described (Malikowski et al., 2007) was applied in this study, particularly in selecting which features to analyze. Analyzing all 30 features contained on the form was untenable, so the research model mentioned earlier was used to select six features for further analysis. These were the number of: 1) Files provided for students, 2) Asynchronous discussion postings, 3) Quiz questions available for students, 4) Drop box files to a professor, 5) Grade book entries, and 6) Survey questions.

Results

Two types of results are described in this section. First, descriptive statistics are provided to show basic trends, and second, an analysis with inferential statistics is provided to determine which trends were statistically significant and which could have occurred by chance.

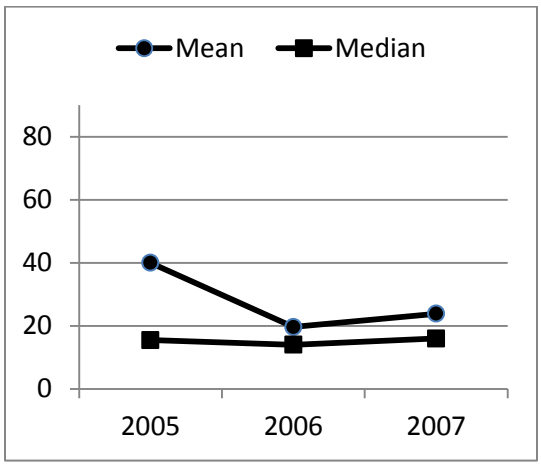

Figure 1. Files provided for students

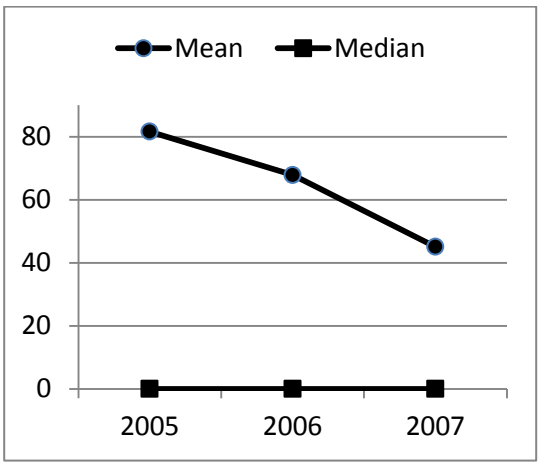

Figure 2. Asynchronous discussion postings

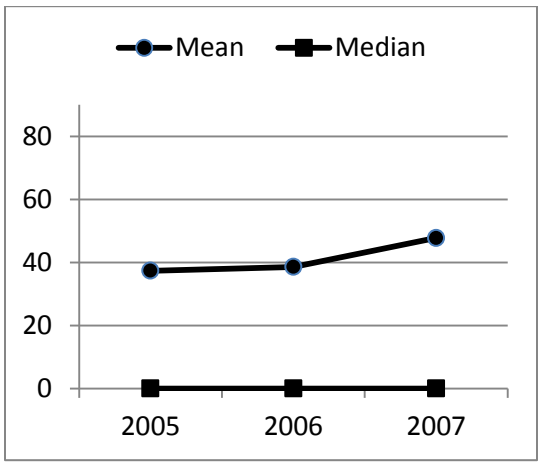

Figure 3. Quiz Questions

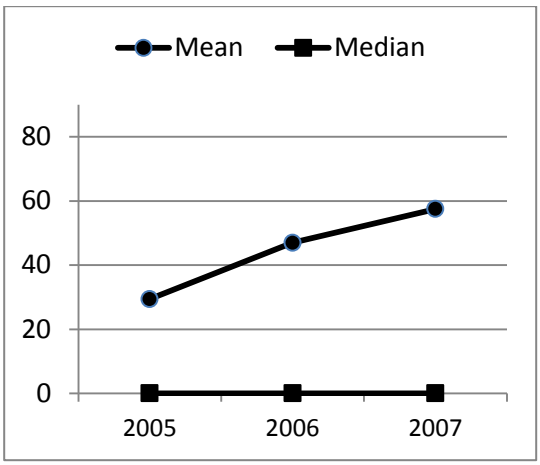

Figure 4. Drop box files to professor

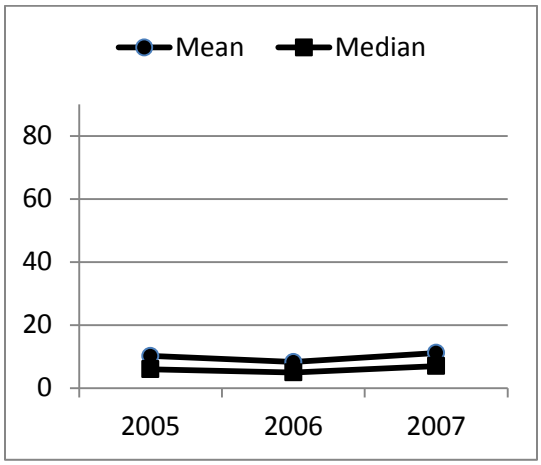

Figure 5. Grade book entries

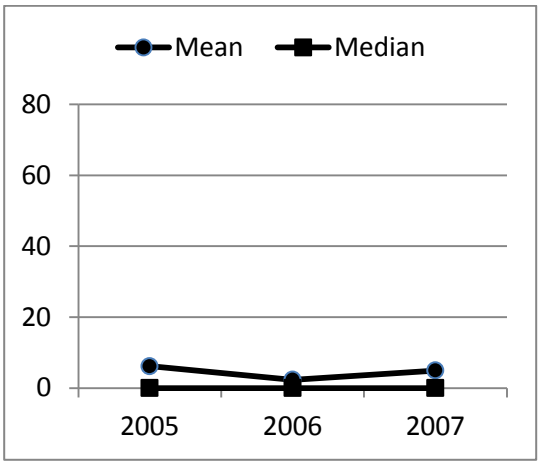

Figure 6. Survey questions

Table 1
Files provided for students

	Mean	Median	Max	SD	N
2005	40.01	15.50	3,027	245.00	152
2006	19.67	14.00	196	23.86	327
2007	23.87	16.00	144	25.87	363
Total	25.15	15.00	3,027	106.48	842

Table 2
Asynchronous discussion postings

	Mean	Median	Max	SD	N
2005	81.61	0.00	2,913	326.60	152
2006	67.85	0.00	3,040	330.78	327
2007	45.05	0.00	5,168	298.903	363
Total	60.50	0.00	5,168	316.585	842

Table 3
Quiz Questions

	Mean	Median	Max	SD	N
2005	37.35	0.00	455	91.70	152
2006	38.57	0.00	1,743	171.51	327
2007	47.78	0.00	1,990	176.86	363
Total	42.32	0.00	1,990	162.48	842

Table 4
Drop box files to professor

	Mean	Median	Max	SD	N
2005	29.39	0.00	641	91.23	152
2006	46.96	0.00	999	143.69	327
2007	57.51	0.00	1,930	182.20	363
Total	48.34	0.00	1,930	154.56	842

Table 5
Grade book entries

	Mean	Median	Max	SD	N
2005	10.19	6.00	60	12.47	152
2006	8.27	5.00	69	11.35	327
2007	11.15	7.00	221	16.52	362
Total	9.86	6.00	221	14.03	841

Table 6
Survey questions

	Mean	Median	Max	SD	N
2005	6.17	0.00	240	24.15	152
2006	2.36	0.00	142	12.34	327
2007	4.97	0.00	242	18.42	363
Total	4.17	0.00	242	17.67	842

Basic Trends

Tables 1-6 and Figures 1-6 show descriptive statistics for each of the six features considered in this study, categorized by year. These figures and tables show an unusually wide variation in the use of CMS features. Tables 1-6 show this variation in the large range and standard deviation. Figures 1-6 show this variation by including both the mean and the median. Since mean values are affected by large numbers, they show larger extremes. In contrast, median values are more stable.

One of the strongest findings comes from the median values. Four of the six features have a median value of zero for all three years of the study, showing that at least half of the CMS Web sites contain no use of these features. The two features with median values greater than zero were providing files for students and grade book entries, in Figures 1 and 5. Both these features involve transmitting information to students, in contrast to interactive features, which has also been found in other research.

Another important finding comes from the trends shown in Figures 1-6. The results are mixed. Two trends show a consistent increase over time, shown in Figures 3 and 4. Three trends show increases and decreases, shown in Figures 1, 5, and 6, and one trend shows a consistent decrease, shown in Figure 2. Of the three figures that show increases and decreases, two of them show an overall decrease, shown in Figures 1 and 6. Figure 5 showed an overall increase, but it was less than a 1 point increase, from 10.19 to 11.15. The overall result of Figures 1 – 6 and

Tables 1-6 is that use of common CMS features decreased as often as they increased, in terms of mean values. In terms of median values, zero was the most common value, and non-zero values occurred with features for transmitting information to students.

Significant Differences

The wide variation previously described affected the inferential statistics that were used, to identify statistically significant differences over the three years in this study. Typically, some type of parametric analysis would be applied for identifying significant differences over time. However, parametric analysis assumes the data are normally distributed, which is not the case here. In this case, a non-parametric test is appropriate (Leech, Barrett, & Morgan, 2008). Specifically, the Kruskall Wallis test was used to determine if differences existed for any feature over three years, at a significance value of $p<.05$. When significant differences were found, the Mann-Whitney test was used to identify the specific time and feature that significantly changed, at a significance value of $p =< .01$. A more challenging significance value was used for the Mann-Whitney test to reduce the chance of a Type I error due to multiple tests.

Table 7 shows the general analysis provided by the Kruskal Wallis test. Four features showed differences at the $p < .05$ level. These features are drop box files, discussion postings, grade book entries, and survey questions.

Table 7
General Analysis by Year with Kruskal Wallis

	Files for Students	Quiz Questions	Dropbox Files	Discussion Postings	Grade book Entries	Survey Questions
Chi-Square	5.169	5.954	6.418*	7.265*	9.823*	10.811*
Df	2	2	2	2	2	2

* Asymp. Sig. (2-tailed) < 0.05

Table 8 shows which features changed significantly over which years, using the Mann Whitney test at $p =< .01$. Four significant findings occurred. Between 2005 and 2006, the number of survey questions significantly decreased. Between 2006 – 2007, the number of grade book entries and the number of survey questions significantly increased. It is worth noting that both these significant increases were preceded by decreases from 2005-2006, as shown in Figures 5 and 6. Therefore, these significant increases could be an elevated version of regression toward the mean, from 2006 - 2007. A final significant finding involves the number of discussion postings. They significantly decreased between 2005 – 2007.

Table 8
Specific Differences for Each Year

	2005-2006			2006-2007			2005-2007		
	Mann-Whitney	*Z*	*p*	Mann-Whitney	*Z*	*p*	Mann-Whitney	*Z*	*P*
DrobBox Files	24086	-.740	.459	55515	-1.874	.061	24884	-2.229	.026
Discussion Posts	23766	-1.012	.311	55914	-1.861	.063	24763 *	-2.578	.010
Grade book entries	22457	-1.775	.076	51392 *	-3.094	.002	26577	-.623	.533
Survey Questions	22907 *	-2.577	.010	54699 *	-3.117	.002	27537	-.052	.958

* Asymp. Sig. (2-tailed) <= 0.01

Discussion

This study was conducted about ten years after CMSs became common at American Universities (Allen & Seaman, 2004, 2005; K. Green, 2001). After this amount of time, it is reasonable to expect that some type of stable-state would occur. When both the significant and non-significant results are considered, a stable-state of CMS use emerged during or before this study. The stable state includes a small number of features that are being used significantly more or less, with most of the features showing non-significant changes over three years.

Evidence of a Stable State

The strongest evidence of this stable state is that only one feature, of the six features analyzed, showed a significant change in use over all three years. The number of discussion postings significantly decreased from 2005 - 2007. A possible explanation of this significant decrease is that professors tried using asynchronous discussions but realized that the benefit and effort involved in technology-based discussions did not compare well to in-person discussions, during class time or office hours. There are pedagogically-strong uses for asynchronous discussions (Johnson & Johnson, 1986, 2004), but presumably, professors in this study were not aware of these uses or chose not to apply them.

The number of non-significant findings also support the conclusion that a stable-state occurred. A total of 18 tests were conducted in this study. Specifically, there were six CMS features over three time periods, 2005-2006, 2006-2007, and 2005-2007. As shown in Tables 7 and 8, only four of these tests resulted in significant change, and two of these results could have been due to a Type I error, grade book entries and survey questions. As stated earlier, both these significant increases were preceded by decreases. Therefore, these significant increases could have occurred due to an overcorrection toward the mean, leading to a Type I error. Even if the doubts of these two findings are dismissed, there were 14 non-significant findings among the 18 tests, which is a situation where the use of 77% of features showed no significant change.

The definition of “stable state” becomes important at this point. Reasonable challenges could be made about the use of this term, to summarize this study. For example, the current findings could be called a partial stable state, a mildly changing state, or something else. These other terms could be appropriate, but their definition would need to be based on additional research in computer systems, hopefully in CMSs. The current use of “stable state” was selected because it shows that use of most features are not undergoing significant change. Any system

involving humans is unlikely to encounter no significant change, which is more of a "stagnant state."

Having said all this, the terms describing CMS use still vary. One example comes from the terms to describe how a CMS is used in a course, such as online, blended, hybrid, Web-enhanced, and others (Allen & Seaman, 2004, 2010; Malikowski et al., 2007). Further analysis of terms in CMS use is beyond the scope of this report, but it is an area for further research, since lack of standardization makes it more difficult to build upon past research and even to efficiently communicate about current CMS issues. Until a time when terms are more clearly defined, research could benefit from operationally defining key terms, in summaries or literature reviews. An operational definition of the stable state that appeared in this study is "Trends in CMS use where over 75% of features did not change in statistically significant ways for resident courses."

Specific characteristics of this stable state can be derived from Figures 1-6, particularly in the median values. As previously mentioned, a median value of zero shows a situation where at least half of the CMS Web sites analyzed did not contain a particular feature. In the current study, that means that at least half of the Web sites did not contain asynchronous discussion postings, quiz questions, survey questions, or files in the drop box from students. All of these items are either interactive or receive information from students. In contrast, the median value was greater than zero for features used to transmit information to students, such as PowerPoint files or grades, as shown in Figures 1 and 5.

These findings are consistent with other research that has analyzed CMS use in resident courses (Ansorge & Bendus, 2003; Craig, 2002; Malikowski, 2008; Malikowski et al., 2006; Morgan, 2003; Nickles, 2006; Woods et al., 2004). The current study added to previous research by showing that few statistically significant changes occurred from 2005 – 2007 and by providing a detailed analysis of common CMS use over three years. During this time, a stable state occurred. The most prominent characteristic of this stable state is that CMSs are primarily used for transmitting information to students and occasionally used for student interaction, such as interacting with other students, professors, or interactive quizzes.

Implications of the Stable State

After a decade of CMS use, the stable state that emerged in this study is disappointing, for at least two reasons. First, the interactive features contain much potential for students to interact with each other or with a computer, such as an interactive quiz with question pools and feedback. Despite this potential, interactive features are only occasionally used. And second, this stable state is disappointing because transmitting information to students can be done with technology that is much simpler and less expensive than a CMS, such as a simple Web page or even email (Bates, 1995; Malikowski et al., 2007).

Since this study was conducted, more features from Web 2.0 have been added to CMSs, and it is reasonable to expect that the features from Web 3.0, 4.0, and beyond will be added in the future. There is a lot of enthusiasm and hope for this new technology (Bonk, 2009; Solomon & Schrum, 2007), just as there was for the arrival of Web 1.0, CMSs, laser disk players, and televisions when they first arrived. It is possible that new, even unknown, technologies will change CMS use so these systems are used for more than transmitting information to students. However, past research cautions against focusing too much on new technology, for reasons that involve pedagogy, reliability, and economy among others (Bates, 1995; Richard E. Clark, 2001; Gagné, Briggs, & Wager, 1992; Russell, 2006).

In contrast to focusing on new technologies, CMS research (Coates et al., 2005) and established research in instructional design (Richard E. Clark, 2001; Hannafin & Rieber, 1989; Russell, 1999; Winn, 2004) contain an ironic recommendation. To move beyond the current stable state, the emphasis needs to be less on technical features and more on the psychological processes and details of human learning (Ansorge & Bendus, 2003; Coates et al., 2005; Malikowski et al., 2007; Morgan, 2003). Gagné took a stronger stance on the issue of how much learning issues need to be considered. "Every neglect of the consideration of how learning takes place may be expected to result in a weaker procedure and poorer learning results" (Gagné et al., 1992, p. 221).

Cognitive psychology is an example of a learning theory that has matured through consistent evidence, scrutiny, and revision (Anderson, 2005; Driscoll, 2005; Neisser, 1967; Winn, 2004). One element of this theory contains a few distinct categories of knowledge. These categories vary slightly among cognitive psychologists, but generally, the categories are attitudes, declarative knowledge, conceptual knowledge, procedures, principles, structured problem solving, and ill-structured problem solving. (Anderson, 1990; Driscoll, 2000; Winn, 2004). Each type of knowledge is best learned with distinct strategies. For example, declarative knowledge, such as facts or jargon, can be effectively learned with repetition, even with flash cards. Concepts, which are basically categories of information, can be effectively taught by giving students examples and non-examples of the concept. In any case, the categories in cognitive psychology provide a framework for analyzing learning needs and clarifying learning goals (R.E. Clark, Feldon, Van Merrienboer, Yates, & Early, 2008; P. L. Smith & Ragan, 2005). Once a set of learning goals are established, specific CMS features are likely to work well to reach these goals, since CMSs contain many features. This may appear like an elementary issue from instructional design or other teaching profession, but it is a fundamentally strong approach to focus more on human learning in CMS research (Ansorge & Bendus, 2003; Coates et al., 2005; Malikowski et al., 2007; Morgan, 2003).

Another advantage of carefully considering learning goals is they can help address barriers that have been identified in CMS research. These barriers include lack of time to create CMS learning activities, lack of funding, and issues related to intellectual property rights (Black et al., 2007; Browne et al., 2006). When a clear learning goal is established, an instructional development model (Gustafson & Branch, 1997; P. L. Smith & Ragan, 2005) can be applied, which can be as simple as the ADDIE model. These models can help overcome barriers by stating the learning goal(s), carefully applying resources, and determining if the constraints can be managed or if the constraints require that the goal be changed. Current research describing barriers to CMS use has not addressed this issue.

Issues for Further Research

One area of further research would investigate issues raised in the previous paragraph. A direct analysis would investigate if or how professors are applying some kind of design model when they create CMS resources. A more involved study could examine if using a design model becomes more common when professors receive assistance from an instructional designer or technologist. Such a study could go even further and investigate if using a design model reduces barriers to CMS use, particularly the early analysis phase of a model. Barriers include such as lack of time, money, or the need for support staff (Browne et al., 2006).

Another area of research could build on the fact that many CMS features existed long before the Web existed, such as computer based quizzes, surveys, and online discussions. These "pre-Web" technologies were extensively researched for their effect on learning outcomes, student motivation, and other issues (Saettler, 1990). The successful, less-successful, significant and non-significant findings of this "pre-Web" research could be used to guide the development of similar CMS learning activities. Intuitively, the results would be the same, but there are some respectable differences, that could change findings when replicating research. For example, CMS based quizzes, surveys, or online discussions are likely more convenient for students to access than their pre-Web counterparts, but convenience also raises challenges, such as assuring a student taking a quiz is actually that student, assuring students work together when they are supposed to, or if students work individually when they are supposed to.

A final area of research could explore the effect of the Sharable Content Object Reference Model (SCORM) on the use of CMS features. One purpose of this model, or technical standard, is to allow CMS learning activities to be used in other CMSs, from a different university, a different CMS brand, or both. Conceptually, this means that a successful CMS learning activity created at one university can be successfully used at others. This should address some of the barriers of CMS use, such as time and money for development. Of course, technical issues can be the easy part of using learning activates from a different university. Differences in curricula, professors' values, and other contextual issues are at least as challenging, but formal research in this area could identify some solutions to these challenges.

Conclusion

Overall, this study found a stable-state of CMS use, from 2005 – 2007, where CMSs are primarily used to transmit information to students. The CMS used in this study was Desire2Learn, which has become functionally similar to other CMSs (Moore, 2005; Morgan, 2003). This study did not explore why professors chose to use CMSs for this purpose. However, findings from this and other CMS research were considered to offer a solution, which could also be an area for additional research. This proposed solution is that CMS learning activities should be created with a clear learning goal and a clear instructional development model. According to past research in instructional design (Dick, Carey, & Carey, 2005; Gagné et al., 1992; Gustafson & Branch, 1997; P. L. Smith & Ragan, 2005), this would start a process where barriers are identified and addressed early and where learning research is carefully considered. This development process can also be used to identify which CMS features, or combination of features (Malikowski, 2008), are best suited to reach the goal.

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