A Model for Research into Course Management Systems: Bridging Technology and Learning Theory

Steven R. Malikowski, Merton E. Thompson, and John G. Theis

St. Cloud State University, St. Cloud, Minnesota

Steven R. Malikowski, PhD Miller Learning Resource Center, 204F Saint Cloud State University 720 Fourth Avenue South Saint Cloud, Minnesota 56301-4498	Email: Office: Fax:	srmalikowski@stcloudstate.edu 320-308-6506 320-308-4778
Merton E. Thompson, EDd Miller Learning Resource Center, 110D Saint Cloud State University 720 Fourth Avenue South Saint Cloud, Minnesota 56301-4498	Email: Office: Fax:	methompson@stcloudstate.edu 320-308-4775 320-308-4778
John G. Theis, EDd Miller Learning Resource Center, 110G Saint Cloud State University 720 Fourth Avenue South Saint Cloud, Minnesota 56301-4498	Email: Office: Fax:	jgtheis@stcloudstate.edu 320-308-3549 320-308-4778

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Abstract

Course management systems (CMSs), such as Blackboard, Desire2Learn, or WebCT, have become a common resource at universities, colleges, and distance learning organizations. Research into how these systems are used for learning is in an early state. Currently, this research focuses on technical features in a CMS more than research about how people learn. This article recommends a model for CMS research that equally considers technical features and research about how people learn. Technical features and learning research are diverse topics. The model was developed by reviewing literature from each topic and should provide a conceptual middle ground. Findings from current CMS research are presented using the model, to show its relevance and adaptability. This model should also ease the process of synthesizing research in CMSs created by different vendors, which contain similar features but label them differently. Implications for developing learning activities in a CMS are also described.

A Model for Research into Course Management Systems: Bridging Technology and Learning Theory

Course management systems (CMSs), such as Blackboard, Desire2Learn, or WebCT, have become a prominent resource at American colleges, universities, and distance learning organizations (Arabasz, Pirani, & Fawcett, 2003; Green, 2001; Morgan, 2003). This prominence comes from using CMSs to enhance resident courses, offer distance learning courses, and support hybrid courses, which combine resident and online courses. A few studies have analyzed how these systems are used and found that CMS features for transmitting information to students are used often, and features for creating interactive learning activities for students are used much less often. These studies have provided useful information, but currently, this research has focused on technical features, instead of offering a balanced analysis of technical issues and research into how people learn. (Ansorge & Bendus, 2003; Dutton, Cheong, & Park, 2004; Morgan, 2003; Woods, Baker, & Hopper, 2004).

This article proposes a model for CMS research that equally considers technical features in these systems and conceptual issues about how people learn. Categories in the model relate to these features and issues. The categories are transmitting information to students, creating class discussions, evaluating students, evaluating courses, and creating computer based instruction. Detailed information about each category will be provided. This article will begin by describing CMS resources that can be useful for higher education, with an emphasis on the value of interactive features. It will then describe why a model for CMS research is needed, define the categories in the model, and how the categories relate to each other.

CMS Resources for Higher Education

Many CMSs are available for higher education, possibly up to a thousand (Doyle, 2005), but a few have become prominent. For example, colleges and universities in Wisconsin most often use Blackboard or WebCT, with a small number using Lotus LearningSpace or Prometheus (Morgan, 2003). A new vendor in the CMS marketplace is Desire2Learn, which was adopted by the Minnesota State University System (Minnesota State Colleges and Universities, 2006). Regardless of the number of CMSs being used, research is showing that some CMS features are common in the systems used in American colleges and universities (Ansorge & Bendus, 2003; Dutton et al., 2004; Morgan, 2003; Woods et al., 2004), such as features to provide a syllabus to students or to offer a quiz. The description below summarizes common features that exist. In the description, the word "tool" is used to describe a category of features, drawing on the familiar phrase that "Technology is a tool for learning." Also, the word "instructor" refers to anyone using a CMS to lead students to one or more learning goals.

CMSs provide an integrated set of Web-based tools for learning and course management. Some tools are static and allow instructors to transmit information to students, such as a syllabus, assignments, reading materials, and announcements. Other tools are interactive. Some of these tools allow people in a class to communicate, synchronously or asynchronously. Other interactive tools allow students to interact with a computer, such as quizzes or surveys. A final set of tools utilize the integrated nature of CMSs. For example, statistical tools can show if students have viewed information that an instructor transmitted or how students have interacted in a CMS. Most of the tools described here existed before CMSs, through the Web or a previous technology. A unique feature of CMSs is how they integrate the tools in ways that increase their usefulness.

A simple example of how integration increases usefulness is that quiz results can be automatically sent to a CMS grade book, saving instructors time. A complex example is that instructors can set prerequisites for students to view course content. In this case, students could be required to submit an essay to a CMS drop box before an instructor's general comments about the essay appear. Another possible prerequisite is that students can be required to repeat a CMS quiz and achieve a minimal score before seeing the next assignment in a course, which may describe an essay assignment to be submitted to a drop box. These and other interactive tools will be further explained later in this article, as the proposed research model is described.

Reasons for a CMS Research Model

There are three reasons why a CMS research model is proposed. First, research into these systems is currently limited but will likely increase because of the popularity of these systems and the diverse set of learning technologies they offer. Second, CMSs offer some unique resources for researchers. The third reason is that current research focuses more on technical features in a CMS than issues related to learning.

CMS Growth

One reason CMS research will likely increase is the popularity of these systems for distance learning courses and resident courses. The number and diversity of CMS features has led to their use in offering distance learning courses, offered over the Web (Allen & Seaman, 2004, 2005; Morgan, 2003). Therefore, the growth in popularity of CMSs is related to the growth in distance learning. Enrollment in these courses has steadily increased in recent years. In the fall of 2002, 1.6 million students enrolled in an online course. In the fall of 2003, enrollment was 2 million, and in the fall of 2004, enrollment was 2.3 million (Allen & Seaman, 2004, 2005).

The growth in use of CMSs is not limited to online courses. These systems are used three times more often to create a Web site for a resident course than they are used to offer distance learning courses (Falvo & Johnson, 2005; Green, 2001; Morgan, 2003). One explanation for CMSs being used more in resident courses is that more resident courses exist than distance learning courses. Arabasz, Pirani, and Fawcett (2003) provide another explanation:

> Of the three major "flavors" of e-learning employed in the United States—fully online, hybrid, and technology-enhanced traditional—the last is most common. This represents a more incremental approach to e-learning adoption, whereas online distance-learning and hybrid courses typically require major adjustments and training in both technology and pedagogy. (p. 29)

Despite the popularity of CMSs for traditional courses, it appears instructors in these courses are just starting to utilize these systems, using the incremental approach described above. As previously mentioned, instructors primarily use a CMS to transmit information to students, such as a syllabus or assigned reading. Features that allow instructors to create interactive learning activities, such as discussions or quizzes, are used much less (Ansorge & Bendus, 2003; Dutton et al., 2004; Morgan, 2003; Woods et al., 2004). This reflects an incremental approach in using CMS features because instructors are familiar with transmitting information—from experience in distributing syllabi, writing manuscripts, using PowerPoint presentations, or attaching files to email messages. They are less familiar with creating computer based interactions, such as facilitating synchronous discussions, asynchronous discussions, or creating quizzes with feedback for each answer.

A final reason to expect more use of more CMS features is that the variety of features in these systems could be used to meet a variety of learning goals. According to cognitive psychology, these goals originate from distinct categories of knowledge. The categories vary slightly among cognitive psychologists, but generally, the categories are declarative, conceptual, procedural, principles, problem-solving, attitudes, and psychomotor. Research in cognitive psychology has also found that each type of knowledge is best taught with distinct strategies (Anderson, 1990; Driscoll, 2000; Winn, 2004). For example, declarative knowledge can be effectively taught with repetition, and conceptual knowledge can be effectively taught with examples and non-examples, but not vise-versa.

A detailed description of how each CMS feature, or more likely combinations of features, can address learning goals from each of these types of knowledge is beyond the scope of this article. However, one brief example will show how CMS features can be combined to address a complex learning goal, which involves declarative, conceptual, and procedural knowledge.

The learning goal in this example is for students to successfully complete an ANOVA in a statistical software package, as part of a statistics course. Students could start by reading an assignment description, which is in a syllabus posted on a CMS Web site. This assignment tells them to read relevant portions of a textbook. The assignment then tells students to discuss practical uses of an ANOVA in an asynchronous discussion. After they have made two postings in the discussion, asking or answering questions, a practice quiz appears about when an ANOVA should be used or not. This quiz could use question pools, which often come from a textbook, so no single student completes the same quiz twice. It is worth mentioning that each quiz could have feedback for correct and incorrect answers. Once students complete this quiz, assigned readings appear about selecting a proper post-hoc test. Relevant discussions and quizzes appear again, after which students meet in class to synthesize their learning in person with an instructor.

This example is elaborate, but it could have started with a single quiz, class discussion, or other interactive CMS feature. The instructor's role in this type of learning activity is to create the learning environment, work with individual student questions, and facilitate class discussions. The instructor could also use the quiz results, which are automatically graded, to diagnose problems with student learning or with the learning activities.

Of course, instructors do not need a CMS to use a variety of teaching strategies or to create complex learning activities. However, the popularity of these systems make them well-suited to encourage instructors to try a variety of teaching strategies to meet a variety of learning goals.

Unique Research Resource

Another reason CMS research could increase is that the level of adoption and integration leads to a unique research opportunity. Fundamentally, instructors from many universities, colleges, and other learning organizations are using a single computer system, with many integrated tools, to reach learning goals. This allows researchers to investigate the work of many instructors in a single system or a small group of instructors focusing on a single feature.

Other diverse research options also become possible or at least more convenient. For example, a single study could analyze asynchronous class discussions, compare this analysis to requirements in a syllabus, and triangulate the data with statistics offered in the CMS. This type of diverse research has always been possible, but it was challenging to implement because data came from multiple sources, instead of one widely-adopted, integrated system. Of course, rigor in the design of such studies must be maintained, but having diverse features and courses in a single system makes it possible to study issues that were previously too complex to carefully analyze.

Current State of CMS Research

Caruso and Sitko are Fellows in the EDUCAUSE Center for Applied Research. They describe the state of CMS research in 2003.

> Most CMS studies focus on attempts to deal with rising costs, CMS marketplace volatility, and buy-versus-build dilemmas. Considerably less research and analysis have been invested in asking whether course management systems are, in fact, being used effectively and, if so, under what conditions. (quoted in Morgan, 2003, p. 5)

A few studies have now analyzed how CMSs are being used for learning (Ansorge & Bendus, 2003; Dutton et al., 2004; Morgan, 2003; Woods et al., 2004). This research typically reports which CMS features are used most and least in addition to opinions from stakeholders about CMS features. This reporting provides an informative perspective about CMS use, but it focuses on technical issues instead of a balanced analysis that includes learning issues. An analysis that balances technical and learning issues would also address the effectiveness of CMSs, as recommended by Caruso and Sitko.

Another reason to consider learning issues comes from the fact that, regardless of their popularity and many features, CMSs are fundamentally a technology or media being used for learning (Gagné, Briggs, & Wager, 1992; Krendl, Ware, Reid, & Warren, 1996). Several models for designing learning activities with media have been developed and are based on empirical research (Andrews & Goodson, 1991). Most of these models build on the work of Gagné. He and his colleagues comment on the value of a model they created, but their comment also relates to other models of using technology for learning. For the sake of the current analysis, their references to media are synonymous to CMS features.

> Surely, the most significant aspect of this design model is its emphasis on the primacy of selecting media based on their effectiveness in supporting the learning process. 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)

This is sage advice, but CMSs emerged more from entrepreneurship and technological affordances than from models of instructional design (Morgan, 2003). In many ways, this spirit of entrepreneurship has continued as instructors use a CMS. Often, they attend a workshop to learn how to use a CMS, and then, they create materials in a CMS on their own (Arabasz et al., 2003; Bennett & Bennett, 2003; Passmore, 2000). These entrepreneurial efforts have led to an impressive level of CMS adoption. However, to advance CMS use in a way that avoids "a weaker procedure and poorer learning results" (Gagné et al., 1992, p. 221), learning research and theories need to be considered in CMS research. The model proposed later in this article is one method of equally considering technical and learning issues.

This section has described reasons why a CMS research model is necessary. Reasons include the broad adoption of CMSs for distance learning and resident courses, the variety of features available, some unique options for researchers, and the need to include more learning issues in CMS research. Of all these reasons, the most prominent reason for a CMS research model is that research into any technology for learning needs to build on previous research about how people learn (Bednar, Cunningham, Duffy, & Perry, 1991; Hannafin & Rieber, 1989a, 1989b).

Related Theory and Research

This section will review theoretical issues related to conceptual models in education. It will also describe the proposed model, how it was developed, and how current CMS research fits into the model.

Theoretical Issues

Since the proposed model emphasizes the value of educational theory in CMS research, issues related to this theory will now be summarized. Driscoll (Driscoll, 1994, 2000, 2005) has summarized and revised many of the salient issues regarding educational theory. She states:

> A learning theory, therefore, comprises a set of constructs linking observed changes in performance with what is thought to bring about those changes. Constructs refer to the concepts theorists invent to identify psychological variables. Memory, for example, is a construct implicated in cognitive perspectives on learning. In other words, we look at the fact that people can demonstrate the same performance time after time and reason that they do so because they have remembered it. We have invented the concept of memory to explain the result. (2000, p. 11)

Ertmer and Newby (1993) provide an additional perspective about learning theories in their analysis of Behaviorism, Cognitivism, and Constructivism. They state "We have consciously chosen not to advocate one theory over the others but to stress instead the usefulness of being well-versed in each" (Ertmer & Newby, 1993, p. 69). They describe each theory in terms of two concepts. One concept is the level of cognitive processing involved in a learning goal, and the second concept is the level of a learner's knowledge related to a learning task. In their description, Behaviorism is best suited for tasks that require low cognitive processing and learners with low levels of task knowledge. Cognitivism is best suited for tasks with moderate levels of the two concepts, and Constructivism is best suited for tasks that have high levels of each. For some, this may be an over-simplified description of these theories, but for the sake of the current discussion, this description provides a basic review of educational theory.

Educational Models

Snelbecker (1999) provides another definition of a theory, and how some scholars use the word "model" to help apply theoretical issues.

> *Theory* refers to an organized set of propositions that are syntactically and semantically integrated (that is, that follow certain rules by which they can be logically related to one another and to observable data) and that serve as a means of predicting and explaining observable phenomena. Some authors use the term *model* to designate a concretization of a theory. (p. 33)

The proposed framework was called a CMS research model because it recommends using educational theory in concrete ways, so that theory and technical features are equally considered in CMS research, particularly developing research questions and analyzing results. The next section will describe categories in the model, what Snelbecker (1999) might call the semantics of the model.

Categories in the Model

There are five related categories in the proposed research model. These categories are: (a) transmitting course content, (b) evaluating students, (c) evaluating courses and instructors, (d) creating class discussions, and (e) creating computer-based instruction. The categories will be described in this section, and relationships between them will be described in the next section. Each description in this section will begin by describing a category and the CMS features that are included in it. The description of CMS features will also summarize research about how often these features are used. Next, the description of each category will recommend issues to consider from educational research and theory. These recommendations are not comprehensive, but they should provide a starting point when studying CMS use in ways that considers both technical features and educational research.

Category 1: Transmitting Course Content

The most common CMS features in this category are those that allow files to be given to students, announcements to be made to an entire class, and grade information to be posted. Theoretical and research issues to consider in this category involve identifying which theory or teaching methods are being applied. These CMS features and research issues will now be described.

CMS Features for Transmitting Content.

Instructors most often use a CMS to transmit course content, such as a syllabus, related reading, or assignment. This course content is most often given to students in the form of computer files uploaded to a CMS. These typically include word processor files, PowerPoint presentations, or HTML files (Ansorge & Bendus, 2003; Dutton et al., 2004; Morgan, 2003; Woods et al., 2004).

Announcements, which are sometimes called news items, are a second form of transmitting course content in a CMS. These are brief messages that appear after students sign into a CMS Web site. The third most common CMS feature for transmitting course content is a grade book. Intuitively, it may seem as if the CMS grade book should be in the category of this model relating to student evaluation. However, instructors actually evaluate students when they grade an essay or create a quiz. The grade book was put in this category because it is used to transmit information about grades. Table 1 shows how often CMS features are used to transmit content.

Table 1
Levels of CMS Adoption for Transmitting Course Content

Research Location	N	Adoption Levels for Most Common Features		
		Transmitting Content Files	News/ Announcements	Grade Book
38 North American Institutions (Woods et al., 2004)	862	86%	Not reported	59%
University of Wisconsin-Milwaukee[a] (Morgan, 2003)	342	80%	81%	57%
University of Wisconsin-Whitewater[a] (Morgan, 2003)	276	67%	87%	47%
University of Wisconsin-Stout[a] (Morgan, 2003)	166	71%	67%	58%
University of Nebraska at Lincoln (Ansorge & Bendus, 2003)	192	69%	Not reported	Not reported
Private US University (Dutton et al., 2004)	191	First and second in a list of 17[b]	Fifth in a list of 17[b]	Ninth in a list of 17[b]

[a]Results for multiple semesters are provided in this study. Data presented here are from the most recent semester, which was spring 2002.
[b]Results from this study were presented as a rank ordered list of 17 CMS features, with the most used features listed first.

One pattern in Table 1 is that announcements are used slightly more often than transmitting content files, but the complexity and value of these features needs to be considered when interpreting these percentages (Ansorge & Bendus, 2003; Dutton et al., 2004; Morgan, 2003; Woods et al., 2004). Announcements tend to be less complex than content files, but announcements are probably less valuable to instructors. For example, an announcement could be used to remind students of an upcoming test. A content file could contain a syllabus or notes about a weekly topic in the class. Both are valuable, but arguably, a syllabus is more valuable and warrants more effort than an announcement.

Information about grades is valuable to instructors, but CMS grade books are complex (Morgan, 2003), which may explain why grade books are used less often than transmitting content files. When faced with the complexity of CMS grade books, instructors may use previous techniques they have developed for recording grades.

Theory and Research Related to Transmitting Content.

In important ways, transmitting content is the most flexible category in this model. Arguably, this category could be used for almost all of the other categories. For example, a word processor file could be used to create a quiz, where students download the file, answer questions in the file, and submit the file to a drop box. However, this model is proposed for the most common and efficient uses for CMS features, instead of instances where one CMS feature is used to perform like another.

One option for considering educational theory is to identify which theory is represented in a set of CMS Web sites. Since CMSs are primarily used to transmit information about a course, a variety of information should be available to determine which educational theory or theories are being applied. Another option for analyzing information transmitted to students is to determine which teaching methods are most prominent for what kind of learning goals. Both of these options could be further analyzed to see if there are differences in relevant factors. For example, results could be analyzed for differences in the college in which a course was offered, class size, or class level, such as 100 or 200.

One research topic involving content files, or media, has involved much debate and research among scholars. This debate focuses on the possibility that one media, typically a new form of media, is inherently better than another media for a particular learning goal. Hundreds of studies have been conducted comparing one media to another (Russell, 1999, 2006). A prominent pattern in these studies is that there is "an overwhelming number of no significant findings" (Russell, 1999, p. xiii), meaning that no particular media or technology is best for a specific learning goal.

Meta analyses of these studies have also been conducted, and further analyses have been conducted on the meta analyses, which shows the high level of interest in this topic. The further analyses have shown that:

> Modest positive gains were noted with a variety of media and individual content areas (for example, math, science, foreign language). However, many individual studies have shown no significant difference between modes of delivery. No one medium emerged as being consistently better or worse in delivering information to students. (Krendl et al., 1996, p. 98).

Considering these issues related to media or content files in a CMS Web site, researchers are encouraged to consider that:

> The learning that occurs from well-prepared media presentations is actually due to three factors or types of variables: (1) learning task type (e.g. more procedural or more declarative tasks); (2) individual learner traits (e.g., motivation, general ability, and prior knowledge); and (3) instructional method (e.g. the way the instructional presentation compensates for deficits in learner traits that are required for learning). (Clark & Sugrue, 1991, p. 341)

Data for the first and third items above could be collected from within a CMS Web site. Data about learners would likely come from other sources and should consider research showing that students value a CMS primarily when its use is clearly related to learning goals. Otherwise, students show a surprising level of disinterest when a CMS is used as a resource for college courses (Kvavik & Caruso, 2005; Morgan, 2003).

Category 2: Creating Class Discussions

CMS features in this category involve tools where class members can interact synchronously or asynchronously. Theoretical and research issues involve student motivation and structured methods for student groups, such as cooperative learning.

CMS Features for Class Discussions.

Class discussions can be asynchronous or synchronous. Asynchronous discussions are like email and give class members time to thoughtfully compose a note before submitting it to a class. One of the authors in this article requires students to add brief quotes from assigned readings into asynchronous discussion messages. Synchronous discussions are conducted in real-time and have a stronger sense of social presence. Unfortunately, messages in a synchronous discussion can scroll off a window quickly, making a challenge for careful reading and responding. Table 2 shows how often these CMS discussions are used.

Table 2
Levels of CMS Adoption for Creating Class Discussions

Research Location	N	Adoption Levels for Most Common Features: Asynchronous Discussions	Synchronous Discussions
38 North American Institutions (Woods et al., 2004)	862	25%	3%
University of Wisconsin-Milwaukee[a] (Morgan, 2003)	342	38%	"Relatively low levels" (Morgan, 2003 p. 68)
University of Wisconsin-Whitewater[a] (Morgan, 2003)	276	28%	"Relatively low levels" (Morgan, 2003 p. 68)
University of Wisconsin-Stout[a] (Morgan, 2003)	166	24%	"Relatively low levels" (Morgan, 2003 p. 68)
University of Nebraska at Lincoln (Ansorge & Bendus, 2003)	192	17%	1%
Private US University (Dutton et al., 2004)	191	Fifth in a list of 17[b]	Last in a list of 17[b]

[a]Results for multiple semesters are provided in this study. Data presented here are from the most recent semester, which was spring 2002.
[b]Results from this study were presented as a rank ordered list of 17 CMS features, with the most used features listed first.

The strongest pattern in Table 2 is that synchronous discussions are rarely used. Morgan (2003) provides one explanation for the low percentages of synchronous discussions, which also reflects a general challenge in CMS research.

> With most course management systems, it is difficult and at times impossible to measure activity without looking at each [CMS Web site for a] course individually. This means we can't always tell whether faculty are using a course site or to what extent they're using CMS features or tools. In addition, some CMS uses are ephemeral (for example, chat, unless the logs are saved), making it difficult to tell after the fact whether or not faculty have used certain features. (p. 19)

One of Morgan's (2003) primary methods of collecting data was usage logs available in some CMSs. This is an efficient data gathering technique, but it focuses on technical features, which means researchers using logs need to be especially deliberate in considering learning issues. The use of CMS logs also describes why Morgan was concerned about ephemeral features, since a computer log would state that a synchronous discussion had not occurred, even if a syllabus, announcement, or asynchronous discussion suggest it did.

Other data gathering techniques can collect data about ephemeral features. Morgan (2003) suggested one when she described the methods of looking at each CMS Web site. This is a time-intensive process of viewing a Web site and counting features, but it is a method to consider to get accurate data. Another method is to survey faculty members about their CMS use, which was the case for studies in Table 2 that reported a percentage. This is not to suggest that surveys should be used to collect data about all CMS features, but surveys can be useful for gathering data about ephemeral features. Better yet, researchers could ask instructors to keep logs of synchronous discussions, or researchers could conduct controlled experiments to identify how CMS discussions can be used to increase learning outcomes.

Theory and Research Related to Class Discussions.

Table 2 also shows that asynchronous discussions are used by just over one quarter of instructors. Romiszowski and Mason (2004) reviewed research related to the use of asynchronous discussions. They focused on issues involving student participation, development of online community, and how asynchronous discussions have shown to have similar learning outcomes as face-to-face discussions. They also make suggestions for moving beyond comparisons of online discussions and face-to-face discussions, such as analyzing asynchronous discussions for "the possibility for learners to analyze their own interactions, or to see a display of their group dynamics" (Romiszowski & Mason, 2004, p. 426).

Another area of research to consider in CMS discussions is the series of studies conducted by Johnson and Johnson on cooperative learning (Johnson & Johnson, 1986, 2004;

Johnson, Johnson, & Smith, 1998). In this research, students were taught how to work cooperatively and put into a variety of groups, such as groups of homogeneous ability or heterogeneous ability. Hooper built on this research by having similar groups work on computer-based instruction (Hooper, 1992; Hooper & Hannafin, 1988; Hooper, Ward, Hannafin, & Clark, 1989). Results of the research by Hooper, Johnson, and Johnson are mixed, in terms of significant findings (Johnson & Johnson, 2004). However, specific issues in this research could be used as the basis for student groups in synchronous or asynchronous discussions.

A final area to consider for research into CMS discussions is to analyze the effects of observable outcomes, such as the learning outcomes in cooperative learning research. Many studies of online discussions have analyzed online community or student satisfaction (Berge & Collins, 1995a, 1995b, 1995c; Romiszowski & Mason, 2004). Research into online community or student satisfaction has provided much information about the learning process, but currently, less information is available about how this process affects observable outcomes or learning goals. In the case of student satisfaction, the outcome may not be related to learning. It could be related to reductions in attrition, but in any case, observable outcomes of CMS discussions could provide an important indicator in research about how to use these discussions.

Category 3: Evaluating Students

The most common CMS tools for evaluating students are a quiz generator, which can also be used to create tests, and a drop box. Theoretical and research issues relate to learning goals, objectives, and the educational theory being applied in a particular course.

CMS Features for Evaluating Students.

CMS quizzes can contain a variety of question types, including multiple choice, multi-select, matching, ordering, arithmetic, long answer, short answer, fill in the blank, and true or false. The quizzing tool in this category is technologically similar to tools described in the next category, Category 4: Evaluating Courses and Instructors. Most CMS research combines tools for evaluating students with tools for evaluating courses, into a single category of "assessment tools." This is an example where categories formed from a technological perspective are different from categories formed from a learning perspective. In terms of technology, similar computer code and features are used to create quizzes for evaluating students and to create surveys for evaluating courses. However, in terms of learning theories, student quizzes and course evaluation surveys address very different purposes. The current analysis will make an effort to keep these categories separate, since this analysis is attempting to move toward a learning perspective in CMS research.

CMS drop boxes allow students to submit a file to an instructor, such as an essay. This feature may not intuitively fit into a category about student evaluation; however, students typically submit files to a drop box with the expectation that an instructor will evaluate the contents, which is why the drop box is in the current category. Table 3 shows how often quizzes and drop boxes are used.

Table 3
Levels of CMS Adoption for Evaluating Students

Research Location	N	Adoption Levels for Most Common Features	
		Quiz	Drop Box
38 North American Institutions (Woods et al., 2004)	862	"75% never used it to administer exams, 59% never used it to administer quizzes" (Woods et al., 2004 p. 287)	"56% never used the Digital Drop Box" (Woods et al., 2004 p. 287).
University of Wisconsin-Milwaukee[a] (Morgan, 2003)	342	25% used "Assessments"	Not Reported
University of Wisconsin-Whitewater[a] (Morgan, 2003)	276	21% used "Assessments"	Not Reported
University of Wisconsin-Stout[a] (Morgan, 2003)	166	27% used "Assessments"	Not Reported
University of Nebraska at Lincoln (Ansorge & Bendus, 2003)	192	Not Reported	Not Reported
Private US University (Dutton et al., 2004)	191	Fifteenth in a list of 17[b]	Not Reported

[a]Results for multiple semesters are provided in this study. Data presented here are from the most recent semester, which was spring 2002.
[b]Results from this study were presented as a rank ordered list of 17 CMS features, with the most used features listed first.

Table 3 shows that CMS quizzes are used by about one quarter of instructors, and drop box use is largely unreported. According to Morgan, data about drop box use was not reported in her research because of its ephemeral nature. Researchers choosing to study drop box use could overcome this problem by asking students or instructors to keep files in a drop box. If files are automatically deleted after being downloaded, other types of data collection could be used, such as surveys, interviews, log files, or records kept by instructors and students.

Theory and Research Related to Evaluating Students.

Evaluation can be formative, summative, and it is based on a learning goal or activities during a lesson. Details more specific than these are influenced by the educational theory being used in the course. To show how evaluation differs with common theories, descriptions will first be given about using CMS quizzes in Behaviorism, Cognitivism, and Constructivism. Then, a description will be given about evaluation issues when using a CMS drop box.

Burton, Moore, and Magliaro (2004) summarized past and present issues with Behaviorism. This theory emphasizes observable changes in learner behavior and deemphasizes issues that cannot be observed, such as cognitive processes. Instructional goals and objectives in Behaviorism state the behavior expected in the lesson. In terms of evaluating students, and teaching students, Behaviorism emphasizes a three step sequence: (a) learners are given a discriminative stimulus, (b) learners respond, and (c) learners are given a contingent stimulus, which involves positive or negative reinforcement depending on the learner's response. A common example of this sequence is a multiple choice question with feedback. Elaborate combinations of this sequence were used in research into teaching machines, in the 1930s. In the 1950s, Skinner further developed and popularized this research. Behaviorism is often criticized for its simplicity, in ways that are not entirely fair or accurate (Burton et al., 2004). Since CMS quizzes are currently used infrequently, this simple approach could be a starting point for researchers to explore methods using these quizzes that may increase learning outcomes and the use of these quizzes.

Cognitivism has become the most influential psychology in the field of instructional design (Driscoll, 2005; Foshay, Silber, & Stelnicki, 2003; Winn, 2004). Unlike researchers applying Behaviorism, researchers applying Cognitivism have analyzed and developed theories for cognitive processes that cannot be directly observed, such as schema theory and situated cognition. One result of this research has been the development of distinct types of knowledge, methods to teach each type of knowledge, and methods to evaluate learning for each type of knowledge. Cognitive psychology does specify goals and objectives, like Behaviorism, but they may not include observable behaviors. For example, cognitive goals and objectives may have students value an idea or describe a process, as opposed to behave in ways that reflect these values or descriptions. In terms of CMS quizzes, cognitive psychology would emphasize cognitive processes at least as much as behaviors. For example, quizzes would contain distinctly different types of questions for concepts, procedures, and problem solving.

Constructivism emphasizes learning goals that originate from the context in which learning will be applied, so if business students are learning how to write a business plan, they will write a business plan from sources a real business would consider. Unlike researchers considering Behaviorism or Cognitivism, "Constructivists are also interested in having learners identify and pursue their own learning goals" (Driscoll, 2005, p. 380). In terms of evaluating students, Constructivism emphasizes methods such as "performance assessment, portfolios, authentic assessment, etc" (Duffy & Cunningham, 1996, p. 186). These types of evaluation are antithetical in many ways to a CMS quiz. This is not to say that Constructivists would never use a quiz, but they emphasize them less than other theories of learning (Driscoll, 2005; Duffy & Cunningham, 1996). Since Constructivism emphasizes authentic documents and portfolios, they would likely use a CMS drop box, which is described next.

Instructors use a CMS drop box to receive computer files from students. These files can contain text, graphics, sound, or any combination of these items. Once a student submits the file, an instructor can add comments to the file and return it to the student. The versatility of a drop box makes it suitable for many learning theories. In any case, the educational theory being applied in a course or learning goal needs to be considered when studying the use of a drop box.

Category 4: Evaluating Courses and Instructors

CMSs allow students to evaluate a course or teacher by using a quiz or dedicated survey feature, but unfortunately, very little data about these features is available. This section will describe these features, summarize how often they are used, and suggest research to consider when studying them.

CMS Features for Evaluating Courses and Instructors.

As previously mentioned, most studies combine the analysis of CMS quizzing tools and survey tools. This could be because they are technologically similar or because some CMSs have a dedicated survey feature, with other CMSs using a quiz for evaluating courses or instructors.

Morgan (2003) found that "Faculty members also use the quiz tool as a survey and feedback instrument to gauge student learning and experience" (p. 70). But, no information was given about how often this surveying technique was used. Another study found that “Surveying Students” was ranked sixteenth of seventeen items (Dutton et al., 2004).

The primary pattern in research about CMS surveys is that they are infrequently used, even though student surveys are a prominent part of higher education. Ironically, this prominence may explain the limited use of CMS surveys. It is possible that colleges and universities have established systems for completing and processing these surveys. These legacy systems are likely not compatible with the surveys available in a CMS.

Theory and Research Related to Evaluating Courses and Instructors.

Wachtel (1998) reviewed literature on student evaluations from 1927 to 1995. He found several topics that could be considered in the use of CMS surveys. Some of these topics are listed below.

- Support and opposition to student evaluations
- Timing of the evaluation
- Class size, topic, or level, such as 100 or 200
- Instructor's gender, reputation, appearance, and personality

- Student's gender, age, and emotional state

Research in any of these areas could also consider Marsh and Roche's (1997) description of validity, reliability, and construct-validation when surveying students about courses or instructors. They argue that a survey instrument and the process of using this instrument needs to consider a similar level of analysis, scrutiny, testing, and revision as instruments used in formal research.

Category 5: Creating Computer-Based Instruction

People who created computer based instruction (CBI) in the decades before the Web existed may grimace at the thought of this category, since creating CBI in a CMS has been limited at best (Foshay & Preeese, 2005). However, options for creating CBI in a CMS have grown with the number and complexity of CMS features. Despite this growth in options, CMS-based CBI has not been reported in current research. This category was included in the model because it offers techniques to use a CMS for more than transmitting content. These techniques also build on research into CBI.

CMS Features for Creating CBI.

A CMS quiz can be a simple form of CBI. These quizzes can contain a variety of question types, feedback for correct answers, incorrect answers, and use random question pools. These features can be helpful for drill and practice, which are "an excellent instructional method for learning lower-level procedures, skills, or concepts" (Hooper & Reinartz, 2002, p. 312).

Other features in popular CMSs can use quizzes for controling access to other CMS content—such as text, graphics, video, or other media—until a minimal score or number of attempts has been completed on a quiz. These features could be used to create simple versions of tutorials (Hooper & Reinartz, 2002) or adaptive instruction. Ross and Morrison were early researchers of adaptive instruction, and they describe its benefits.

> One of the computer's most powerful capabilities lies in *adapting* instruction to students. … One common example, similar to programmed instruction, consists of adaptive branching to different lesson segments depending on which multiple-choice alternative the student selects. Another is evaluation of the student's on-task performance to determine whether the lesson should end, additional practice problems should be presented, or some other action should be taken. (1988, pp. 227-228)

One way to accomplish adaptive instruction in a CMS is with quizzes that use question pools (Salisbury, 1988). For example, a pool could contain 100 questions, possibly from a CD that comes with a textbook. Consider two quizzes in this example. One quiz would be for practice only and randomly draw 10 questions from the pool. These questions could have feedback for correct and incorrect answers. Then, a second quiz could evaluate students on the content, without drawing questions from the pool or drawing questions from a second pool. If students did not meet a minimal level on the second quiz, they would receive a message that they must re-take the first and second quiz. Record-keeping within a CMS would show instructors if a student repeated the quizzes, the number attempts that were made, and what the student's grade(s) were on the second quiz. This instruction is moderately adaptive because students who need more assistance receive it. With a careful combination of presenting various media in a CMS, asking quiz questions, and providing different content for different answers, more complex forms of adaptive CBI could be created.

A challenging issue is determining when a CMS quiz belongs in this category and when it belongs in the category of "Evaluating Students," which also includes quizzes. Since this area has not been analyzed by CMS researchers, little information is available for determining the category in which to place a quiz. Therefore, the authors offer a theoretical and technical perspective. Theoretically, the purpose of a quiz helps determine the category. If it is evaluating a student for a terminal objective or final grade, it would belong in the "Evaluating Students" category. If it is used for an enabling objective it would be in the current category. Technically, a simple quiz, with no feedback or other CMS quiz options, would likely be in the category of evaluating students. A complex quiz, which includes correct feedback, incorrect feedback, or other CMS quiz options, would likely be in the current category. More conclusive guidelines for CMS quizzes will likely arise as CMS-based CBI is developed and researched.

Theory and Research Related to Creating CBI.

The role of theory in creating CBI is similar to the role of theory in assessment, which was previously described. Like assessment, CBI is shaped by the theory being applied in a lesson (Burton et al., 2004; Jonassen, Peck, & Wilson, 1999; Wagner & Gagné, 1988). Examples considering Behaviorism, Cognitivism, and Constructivism will now be described. A lesson that considers Behaviorism could nearly recreate the teaching machines that Skinner and others made decades ago (Burton et al., 2004). In this case, the CBI would show a stimulus, ask students for a response, and give students another stimulus based on their response. CBI that considers Cognitivism would follow the teaching methods shown to be effective for different types of knowledge, such as declarative, conceptual, procedural, or problem solving (Anderson, 1995; Driscoll, 2000; Wagner & Gagné, 1988). And last, CBI that considers Constructivism could give students a problem to solve and resources to consider in the solution. These resources could be information resources, CMS discussions, or cognitive tools (Hooper & Reinartz, 2002; Jonassen et al., 1999). Cognitive tools "are resources for recording, analyzing, and organizing information" (Hooper & Reinartz, 2002, p. 315).

Options for CMS-based CBI are limited compared to multimedia development software that has been available longer the Web has existed (Hooper & Reinartz, 2002). However, advantages still exist for creating CBI in a CMS, at least when elaborate CBI is not needed. First, CMSs are already available to many instructors. Second, instructors could start by making a CMS quiz, which about 25% are already doing. And third, options for adding complexity have become available, such as the ability to show CMS content only after a minimal score on a quiz.

Summary of Categories in the Model

This section has described five categories in the proposed research model. These categories are: (a) transmitting course content, (b) evaluating students, (c) evaluating courses and instructors, (d) creating class discussions, and (e) creating computer-based instruction. Each category was presented in terms of current research and options for conducting future research, in ways that equally consider technical features and learning theory.

The most prominent use of a CMS is to transmit information to students. A category showing moderate use is creating class discussions, primarily asynchronous discussions. Tools in the category of evaluating students are receiving low to moderate use, particularly with quizzes. Tools in other categories are receiving very little use.

Considering the research described in these categories, it appears that, as a group, instructors are in an early phase of CMS adoption. Arguably, they are using a CMS in familiar ways, such as transmitting information or completing grades. Research into individual categories can explore more effective ways to use more CMS features. Research could also explore relationships among CMS features or categories, which is described next.

Relationships Among Categories

Returning to Snelbecker's (1999) description of a model, the previous section described semantic elements of the proposed model. This section will show syntactic elements, by showing and describing relationships among the categories that were previously described. Figure 1 shows these relationships.

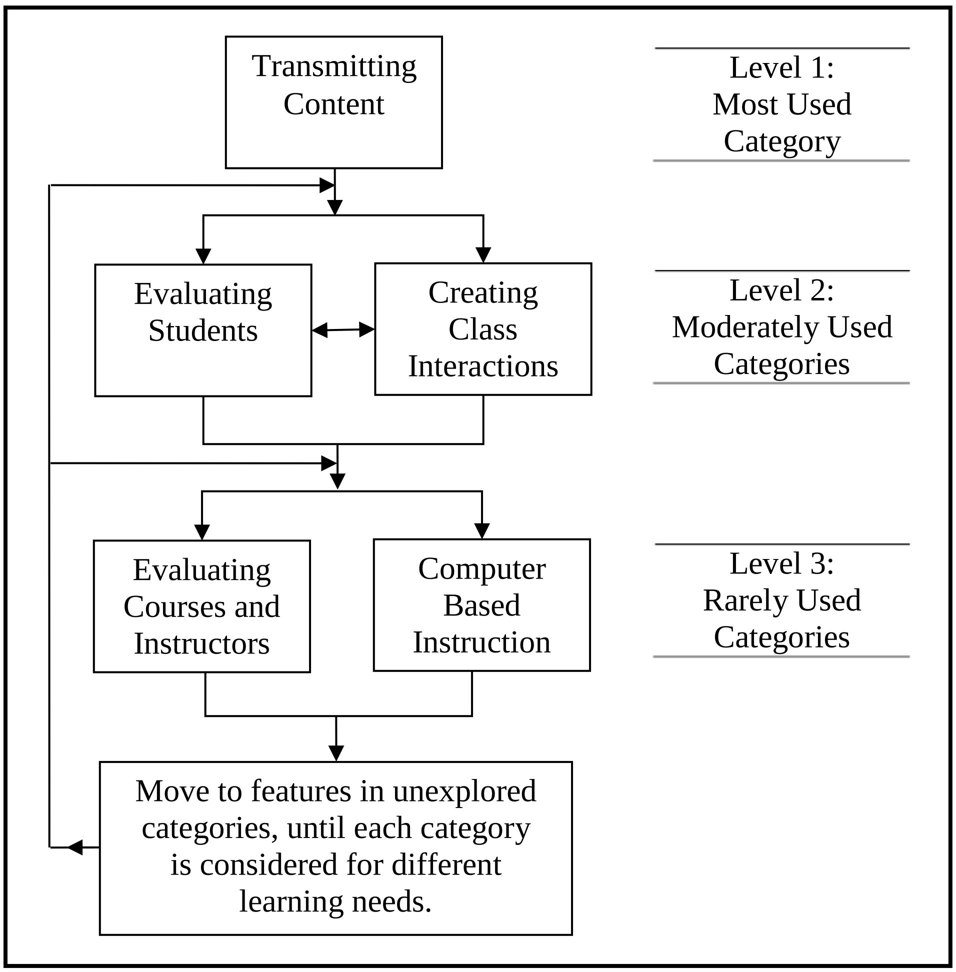

Figure 1. Flowchart of Research Categories

The purpose of the flowchart in Figure 1 is to suggest how instructors adopt CMS features to address diverse learning goals, using the five categories of CMS features. The flowchart will now be explained in terms of the relationships among categories and how it can be used in CMS research.

Relationships Among Flowchart Categories

In the flowchart, research categories with the most used CMS features appear near the top and are labeled as "Level 1." Research categories that have been adopted moderately often are in the middle and labeled as "Level 2." The least adopted CMS features are at the bottom and labeled as "Level 3."

The levels and arrows are based on research findings summarized in the previous section of this article. Since CMSs are used by most instructors to transmit content, this category was placed at the top of the flowchart, at Level 1, suggesting that instructors transmit content when they first use a CMS. CMS features for evaluating students or creating discussions are adopted much less often than transmitting content, so the flowchart suggests categories containing these features are adopted after instructors have transmitted content in a CMS. The lowest categories on the flowchart contain CMS features that instructors infrequently use, which are student surveys and CBI. The flowchart suggests these features will be used by most instructors only after they have used features in the Level 2 categories. The lowest level in the flowchart suggests new features will be adopted when instructors identify learning needs that can be met with additional CMS features.

Research Issues

One research issue is to determine if the flowchart accurately describes the sequence in which instructors adopt CMS features. This issue could be analyzed by observing if features in a particular level are commonly used without using features from a previous level. If this commonly occurs, the sequence of the categories would need to be adjusted.

Another research issue is to determine if adopting specific CMS features in one category leads to adopting features in other categories. For example, CMS quizzes are in the Evaluating

Students category, but quizzes are functionally similar to surveys or CBI, which are in the Level 3 categories. Researchers could analyze if experience using quizzes for evaluating leads to using surveys for evaluating courses or to creating CBI.

A final research issue is to see if using a CMS actually helps instructors to use more diverse teaching strategies for different learning goals. One method for this research would be to monitor some instructors over time. At the beginning of such a study, the number of teaching strategies an instructor uses could be counted, with an interview, syllabi analyses, observation, or some combination of these factors. Then, the instructors could be given one or more training sequences in using a CMS, which are typically offered with workshops (Arabasz et al., 2003; Bennett & Bennett, 2003; Passmore, 2000). These sequences could have intentionally different content, such as focusing on different learning theories or levels in the flowchart. The end of such a study could once again count the number of teaching strategies an instructor uses to see if the number of strategies changed during the study. A variation of this study could give pre-tests and post-tests to students, to see if any increase in the number of teaching strategies leads to increases in learning outcomes. This type of research could help revise the flowchart in Figure 1 and make recommendations for designing CMS workshops for instructors.

Conclusion

An increasing number of instructors will likely be asking questions about how to effectively use a CMS because of the popularity of these systems. These instructors could have no experience with a CMS or a decade of experience. Researchers will be as likely to increase the number of studies they conduct on CMSs. These increases are two reasons why the model in article was proposed. A third reason is the unique resources CMSs offer researchers, such as the ability to conveniently analyze multiple courses using multiple features in a single computer system. However, the most important reason for developing the proposed model is that current CMS research has focused on technical issues, such as which features are used most. This research provides helpful information, but in order to advance CMS use in ways that increase learning outcomes, CMS research needs to equally consider technical issues and research about how people learn.

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