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Instructional Technology in Business Education: An Examination of Online Learning Styles

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Abstract: Management education has rapidly adapted to recent technological advances with initiatives ranging from Web-based degrees conferred by online schools to hybrid courses offered on traditional campuses. Despite the substantial growth in these programs, however, the field's understanding of the effects of these initiatives is relatively limited as only a few management education researchers have empirically investigated the actual use of instructional technologies. The present study adds to the developing empirical literature by examining Web log server data generated by undergraduate students enrolled in a Management Information Systems course where an online Learning Management System (LMS) was used to complement a traditional classroom environment. We adopt a comprehensive model of student learning to guide the pursuit of two research questions: 1) How do students use online instructional technologies? and 2) What effect does such usage have on student learning? Our findings indicate that distinct usage patterns are reflected in how students actually use instructional technologies and that there are gender differences in these patterns. These findings illustrate the potential role of online learning styles in the consideration of the effects of instructional technologies on student learning.

INTRODUCTION

Students currently enter higher education institutions with expectations that technology will be provided, and once admitted, indicate that they prefer learning environments in which instructional technology is available (Carlson 2005; Harley et al. 2003). Business education has rapidly adapted to these conditions with initiatives ranging from Web-based online degrees conferred by online schools to hybrid courses offered on traditional campuses. Despite the substantial growth in these programs, however, only a few business education educators have empirically investigated the use of these technologies (Alavi & Gallupe 2003; Arbaugh 2005a). Accordingly, our understanding of the effects of these initiatives on management education is relatively limited.

The present study adds to the developing empirical literature by examining Web log server data generated by undergraduate students enrolled in a Management Information Systems course where an online Learning Management System (LMS) was used to complement a traditional classroom environment. Specifically, we adopt a comprehensive model of student learning to investigate LMS usage patterns and the effects of those patterns on student performance outcomes. As reported below, we find four distinct usage patterns as well differences in the level and variation of LMS usage by male and female students.

This study represents an exploratory study as a part of a larger student learning research project investigating the relationships between instructional technologies, student learning styles, instructor teaching styles, and student learning outcomes. Accordingly, this project continues the development of the research direction proposed by Arbaugh and Stelzer (2003), as well as responding to Alavi and Leidner's (2001) call for additional depth in theoretically-grounded empirical research on the interaction of technology, instructional method, and student learning. We also contribute to the literature by using a new type of primary data, actual student usage of instructional technologies recorded on a Web server in contrast to prior work that had previously examined only survey data. This new type of data also allows us to contribute to the research by testing new hypotheses regarding online learning style patterns.

The remainder of this paper is divided into the following sections. First, we review education research from business and other disciplines to illustrate a comprehensive model of learning with instructional

technologies. Second, we state our questions regarding online patterns of student behavior and the potential effects on student learning. Next, we describe our methodology followed by our results. We then close the paper with discussion of our findings.

RESEARCH MODEL

The various literatures have not adopted a common terminology regarding the term instructional technology. Terms such as online technology, Web-based courses, learning management system, asynchronous learning network, and computer-mediated instruction have been used to describe many approaches in the use of instructional technologies. In this portion of our paper, we use the term instructional technologies to be inclusive of all the terminologies and systems previously used.

Three broad research streams crossing many disciplines have examined the development of instructional technologies. One stream has prescribed how instructors and institutions should use instructional technologies to create innovative projects, course web sites, courses, management systems, and programs (Bergman & Bergman 2003; Morgan 2003; Twigg 2001). For business educators, research of this type has recognized key organizational, learning, and teaching practices and processes (Alavi & Gallupe 2003; Arbaugh & Stelzer 2003). A second stream of work has sought to determine whether there are significant differences in outcomes between new technology-based and traditional courses (Harley et al. 2003; Phipps & Merisotis 1999). Although the majority of the early research here indicated no significant differences between student outcomes, this work has been criticized for methodological problems (Phipps & Merisotis 1999) and for omitting constructs such as instructional design and teaching style (Arbaugh 2000a; Hiltz & Wellman 1997). Findings from more recent rigorous research are still mixed. Benbunan-Fich and Hiltz (2002) reported no significant difference between perceived learning and course mode delivery (completely online, mixed, completely on campus) but significantly lower grade performance for on campus learning environments. Arbaugh (2000b) found no significant differences between perceived learning reported by students in online and traditional MBA courses.

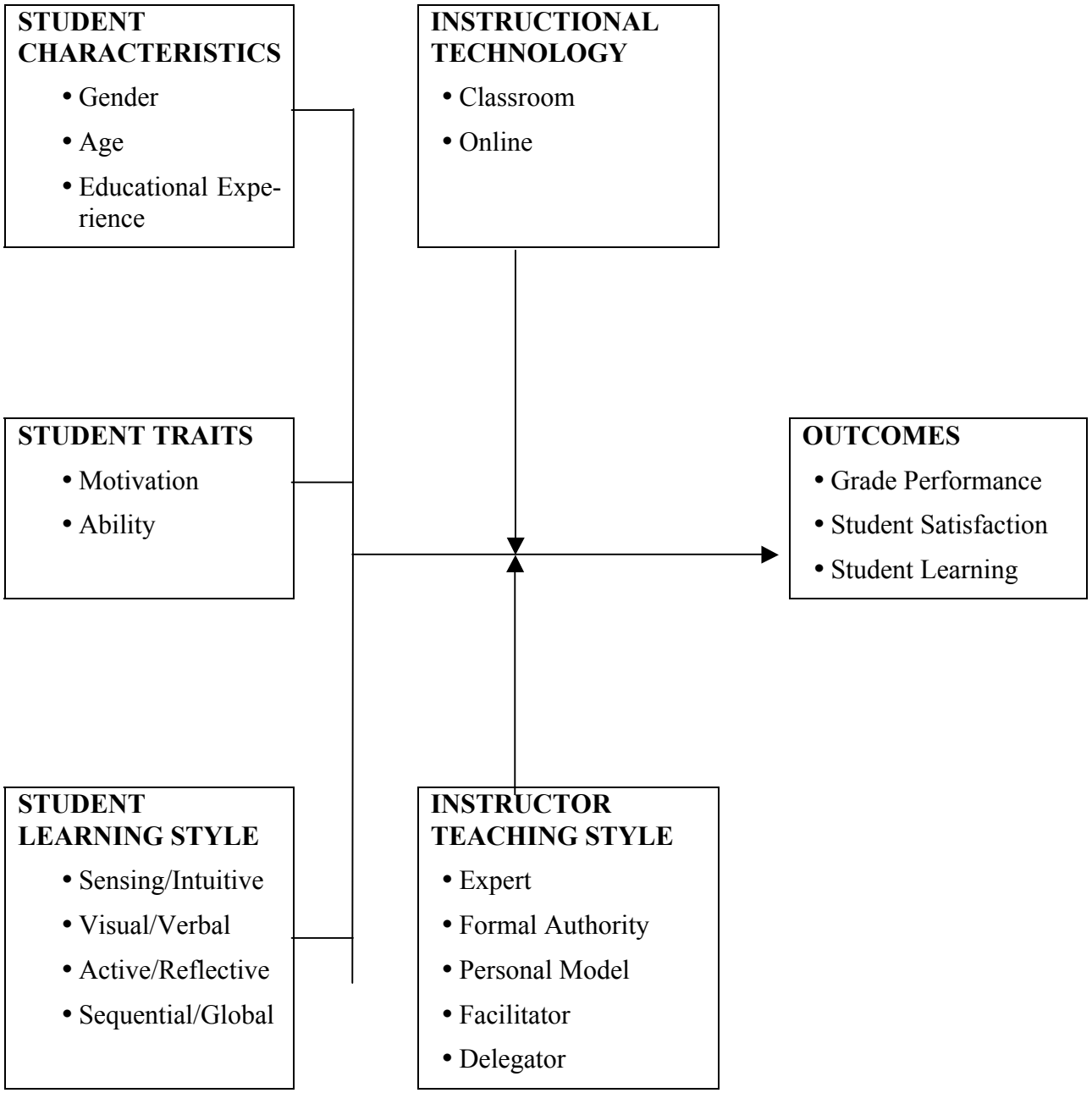
The third and most recent stream of research has developed integrative models focusing on teaching and learning with instructional technologies. Researchers in this stream have started to empirically explore the potential influences of both extrinsic and intrinsic factors on several dimensions of student outcomes, including student satisfaction, learning, and course performance. For example, Alavi and Leidner (2001) suggested that examination of the crucial question of how technology enhances learning requires attention to relationships between instructional, psychological, and environmental factors. Similarly, Arbaugh and Stelzer (2003) suggested that relationships with and interactions between student characteristics, student learning, and instructor pedagogical styles are fundamental to understanding the role of faculty in Web-based courses. Clearly, this research emphasizes the crucial influences on and interdependencies between learning and teaching that affect student outcomes.

Our research builds on this third stream of work examining a comprehensive model of teaching and learning. Although the learning context model suggested by Alavi and Gallupe (2003) has influenced us, our model of student learning, as represented in Figure 1, focuses more specifically on students and teachers, and as such, is consistent with recent work performed by business (Brokaw & Merz 2000), management (Marks, Sibley & Arbaugh 2005), marketing (Young, Klemz, & Murphy 2003) and engineering (Zwyno 2003) education researchers. Overall, the effects of multiple inputs, such as student characteristics, traits and learning styles, instructional technology, and instructor teaching styles, are considered with outcomes of student satisfaction, learning, and performance.

The conceptual basis for this model rests on theories of learning and teaching developed by educational psychologists as well as researchers from other fields. Student learning has been conceptualized as an individual's perceptual and intellectual activities relating to individual information processing, problem solving, and decision-making (Armstrong 2000). In this context, student characteristics, such as gender, experience, and age, and traits, such as individual motivation and ability, have been found to influ-

ence student performance (Benbunan-Fich & Hiltz2002; Wang & Newlin 2002; Zwyno 2003). In contrast to characteristics and traits, student learning styles are the behaviors that serve as indicators of how learners perceive, interact with, and respond to the learning environment. Although more than fifty different cognitive learning style theories and models have been proposed by scholars (Armstrong 2000), three prominent streams of empirical research have followed from the works of Grasha, Kolb, and Felder. Whereas Grasha's (1996) research is premised a social interaction model of learning and teaching, and Kolb's (Kolb & Kolb 2005) work is based on experiential learning theory, the Felder-Silverman Learning Style Index (LSI) model is focused on differences in information acquisition, processing, and understanding (Felder & Silverman 1988; Felder & Spurlin 2005). Due to this emphasis, Felder's LSI model is adopted in our study examining the usage of instructional technologies.

FIGURE 1
MODEL OF STUDENT LEARNING



Felder's LSI model consists of four dimensions. The active/reflective dimension contrasts the behavior of active learners who retain and understand information by discussing, applying, or explaining it, to reflective learning, which involves contemplation and consideration. The sensing/intuitive dimension points toward preferences for concrete information versus abstraction. The student with sensing tendencies prefers facts and well-established methods whereas intuitive learning entails discovering possibilities and looking for innovative problem-solving techniques and solutions. The visual/verbal dimension rests upon the means by which information is presented. Visual learning involves the images students see – these kinds of learners remember best pictures, diagrams, charts, and demonstrations. On the other hand, verbal learners rely upon words, either written or spoken. Finally, the sequential/global dimension is grounded on the sequence by which information is understood. Sequential learners move in linear steps, where each intermediate step is logically followed until a complete solution is understood. Global learners move in large, seemingly random jumps before they "get it."

Instructor teaching style has also been recognized by learning theorists as necessary in understanding student learning (Felder 1993; Grasha 1996). An objectivist teaching style envisions the instructor as the transmitter of knowledge with the purpose of conveying objective reality as knowledge, whereas the constructivist approach envisions the teacher as supplying multiple sources of information, which is constructed by the learner (Arbaugh & Benbunan-Fich 2003). An instructor's teaching style therefore reflects beliefs and behaviors regarding teaching approaches, instructional design, presentation methods, interaction modes, and practices of management, supervision, and mentoring (Grasha 1996). Accordingly, teaching style can be viewed as a combination of Expert, Formal Authority, Personal Model, Facilitator, and Delegator elements (Grasha 1996).

Accordingly, the model of student learning in Figure 1 reflects our larger research agenda examining the effects of the usage on instructional technology on student outcomes. In the present paper, we explore part of this model by focusing on two research questions:

Are there patterns of online instructional technology usage by students?

What effect does such usage have on student learning?

LEARNING MANAGEMENT SYSTEMS

In exploring our research questions in this paper, we focus on Learning Management Systems (LMS) as a particular online instructional technology commonly adopted by or created in educational institutions. Approximately 90% of all higher education systems have adopted either a proprietary or open-source LMS such as Blackboard, WebCT, or Sakai (Hawkins, Rudy, and Madsen, 2003). While there are multiple forms of and uses for LMS (Boetcher 2003; Morgan 2003), it is a platform for both asynchronous learning environments (file transfers, email, text, graphics, video, audio, and discussion forums) and synchronous learning environments (whiteboards, videoconferencing, and chat) that extend conventional learning environments.

Student Learning Styles

Over the last two decades researchers from multiple disciplines, including business and related fields, have empirically examined differences in student learning styles. Using Felder's LSI, De Vita's (2001) report of the learning style preferences of management undergraduates in Great Britain shows higher levels of active, sensing, and sequential learning and lower levels of visual learning than other studies examining engineering undergraduate students (Felder & Spurlin 2005). Jaju and Kwak's (2000) examination of undergraduates of a large U.S. university indicated that marketing, management, and MIS students exhibited learning preference tendencies towards concrete experiences and active experimentation in contrast to the abstract perception and reflective process preferences of non-business majors. Brokaw and Merz (2000) found that students enrolled in principles of economics courses at an engineering/science

oriented U.S. university tended towards learning style preferences of understanding a wide range of information and putting it into concise logical form, which is consistent with science and information careers but not business.

Only a few researchers have incorporated instructional technology into their learning style analysis. Young and his colleagues (2003) found that the learning style preferences of undergraduate students enrolled in required marketing courses in a U.S. university did not extend to differences in preferences for instructional technology usage. In contrast, Zwyno and Waalen's (2002) examination of Canadian undergraduate students enrolled in an upper-level engineering course showed that students with preferences for intuitive, visual, and active learning had the highest average number of page hits, logins, and pages read, whereas students preferring verbal learning were highest users of email but had the lowest number of logins, hits, and use of web resources. In a study of undergraduate marketing courses in an Australian university, Morrison and his colleagues (2003) reported that learning styles of traditional students differed from on-line students in that on campus students tended to prefer visual and active learning style dimensions, whereas online students preferred sensing, reflective, and verbal dimensions. Furthermore, applying cluster analysis, three learning style groups were found for traditional as well as online students in which different combinations of learning style factors were reflected.

Despite the lack of a clear consensus in this research, these studies suggest that student learning styles are distinguishable and as such, patterns of instructional technology usage should reflect differences in online learning styles. Accordingly, we would expect to find patterns of LMS resource usage that indicative of student learning styles.

METHODOLOGY

Sample

The data were collected in Fall 2004 from two undergraduate sections of a survey Management Information Systems course taught in the business school at a small highly selective private liberal arts university during a twelve-week semester. Thirty-three students were originally enrolled in this elective course; one student dropped and two others did not complete the course, leaving a sample of thirty. The morning section consisted of seventeen students (56.7%) while the afternoon section had thirteen students (43.3%). The final sample of traditional undergraduates includes eleven females (36.7%) and nineteen males (63.3%), sixteen Seniors (53.3%) and fourteen Juniors (46.7%), and majors from the fields of Accounting (n=2, 6.7%), Business Administration (n=24, 80.0%), Computer Science (n=2, 6.7%), Engineering (n=1, 3.3%), and Politics (n=1, 3.3%).

A single instructor taught both sections of the course. The instructor employs a hybrid instructional format, consisting of traditional face-to-face class meetings three days a week integrated with extensive use of a LMS developed by the instructor. Students had access to the LMS by means of desktop computers made available in labs and laptop computers used intermittently in class, both provided by the university, and their own personal (desktop or laptop) computer.

The LMS contains virtually all of the course's required pedagogical resources, other than the material presented during classroom discussion. These course content resources include Course Syllabus, Assignments, Student Grades, Textbook Online, Topical Articles, Real-World Scenarios, Case Guidelines, Case Studies, CyberShows (McCray 2000), Software Development Projects, Software Tutorials, and a Final Case Study. The LMS also includes a variety of pages for team project management, password management, instructor contact information, online textbook password and access, and general navigation (home, menu, and header pages), none of which contain substantive course content. Table 1 provides a brief description of the content contained in the LMS.

TABLE 1
DESCRIPTION OF LEARNING MANAGEMENT SYSTEM CONTENT

Content	Description
Pedagogical Content	
Syllabus	A Web page containing lecture meeting location and times, where to purchase the access key for the online textbook, course description and objectives, major topics covered, course requirements, due dates for major assignments, grading scale, method of evaluating student performance, course policies, and links to various course content.
Assignments	This Web page lists the homework or major assignment due for each class period. The date of the class, the topic to be covered, and the assignment due for that class are provided in a chronological table. The assignment usually consists of set of hyperlinks that are linked to various pedagogical resources contained within LMS. Most of the resources on the LMS must be accessed through the assignments page.
Student Grades	Students may access their grades on individual assignments and their overall average for the course using this dynamically generated Web page. This page is updated as assignments are returned to students. Students may view only their individual grades and the class averages.
Textbook Online	This is an online version of the textbook provided by the publisher and hosted on the LMS. Because it is online and a subset of the textbook it is considerably less expansive than the full paper version. Students purchase an access key at the university bookstore in order to gain access to the textbook on the LMS. Students may access individual chapters or sections of the textbook through the assignments page on the LMS.
Topical Articles	A variety of topic specific online articles from business newspapers, periodicals, and academic journals are hosted on the LMS as Adobe Acrobat files.
Real-World Scenarios	These are online mini-case studies, usually 2 to 2.5 pages in length, that present information technology issues that are being evaluated by real organizations. The real-world scenarios are an integral part of classroom discussion at the conclusion of presenting a major IT topic. Four of these mini-case studies are included in the LMS.
Case Guidelines	A set of pages that provide guidelines on how to analyze a case study and prepare a written document of the analysis and the subsequent recommendations.
Case Studies	Three online case studies are hosted on the LMS. Students must prepare a written analysis and a set of recommendations for each case, as well as, be prepared to actively discuss the case during class the day the case is due.
CyberShows	These are online multimedia mini-lectures that are 10 to 15 minutes in duration. They were developed by the instructor to cover various IT topics before the students attend class. Five CyberShows are hosted on the LMS.
Software Development Projects	These Web pages contain the business scenario along with the functional and deliverable requirements for two Microsoft Access application development projects.

TABLE 1
DESCRIPTION OF LEARNING MANAGEMENT SYSTEM CONTENT – CONTINUED

Content	Description
Pedagogical Content - continued	
Software Tutorials	This content consists of a set of Web pages that contain hyperlinks to ElementK's online interactive multimedia software tutorials as well as the actual ElementK Tutorials. The software tutorials cover the material necessary to complete the software development projects and some homework assignments.
Online Presentations	PowerPoint presentations used during class. The presentations are made available for students to download after they are presented in class.
Final Case Study	The course "final" is an in-depth comprehensive case study. The case narrative, tables, and figures along with the preparation requirements and guidelines are hosted on the LMS. The final case study is due in the middle of final exams.
Logistical Content	
Team Management	This page contains a narrative describing why teams are used for the software development projects, the process used to form teams, and general team management information.
Team Registration	Students in the class use this dynamic Web page hosted on the LMS to form and register their teams.
Change Password	This page allows students to change their default password to a password of their choosing.
Instructor Contact Information	A Web page listing the instructor's office hours, office location, email address, and phone number for the semester.
Access Code	This is a dynamic Web page where students enter the access code they purchased at the bookstore to gain access to the online textbook. When a valid access code is entered the access code is linked to the student's username in a database, so students only need to enter the access code once during the semester.
Navigational Content	
Home Page	This is a splash page that serves as a visual introduction and portal to the LMS. It is also a frame within a frameset that defaults to home, menu, and header pages.
Menu Page	The menu page in the primary navigational page on the LMS. This page contains hyperlinks to the main content areas of the site and is always visible to the student.
Header Page	The header page appears at the top of the frameset and contains graphics and text identifying the course LMS. This page is also always visible to the student.

Students are graded based upon performance on: three case studies, 125 points each (37.5% of total); two software development projects, 125 points each (25% of total); course contribution, 150 points (15% of total), and a comprehensive final case study, 225 points (22.5% of total).

Data Collection and Preparation

During the first day of class, students are instructed on how to access and use the instructor's LMS. Students are also instructed to regularly check the LMS for new or revised assignments, which are posted

approximately ten days before they are due. Occasionally during the semester, students are informed that new material or assignments have been recently posted to the LMS. Each enrolled student is assigned a username but selects their own password as LMS access is not granted to unauthorized users. Web servers track and log all student "click-stream" activity over the entire academic term, including which students access resources, which resources are accessed, when resources are accessed, where resources are accessed from, and how resources are used.

In raw form, the format of the log file data collected by the server is unsuitable for meaningful data analysis. In addition, because the Web server logs any and all activity on the LMS, there is a considerable amount of log file data that is not pertinent to learning style activity. Consequently, a conversion process is necessary to remove non-pertinent data and convert raw data into a format suitable for data analysis.

The LMS Web server for the subject course logged 204,242 entries during the Fall 2004. After completing the data scrubbing and conversion process, there were 27,904 entries, commonly referred to as hits, pertinent to the class under study. Of these, 4,577 hits were logged by the instructor, the instructor's research assistants, or students that did not complete the course and 8,328 hits were by students accessing minor pages (course logistics and navigation), leaving a total of 14,999 relevant hits recorded by the LMS Web server for students in this sample. In addition, a different server hosting software tutorials used in the class logged 764 pertinent hits. Thus, the total number of pedagogical content hits attributable to the thirty students in this sample is 15,763.

Measures

Patterns in online learning styles were measured by frequency of accessing the thirteen LMS pedagogical resources (Chang, Wang, & Da-Tsuen 2000; Garrison, Fenton, & Vaissiere 2001; Lu, Zhu, & Stokes 2000; Nachmias & Segev 2003; O'Hanlon & Roecker 1999; Peled & Rashty 1999). As previously mentioned, students access to LMS content is recorded on the LMS server based on the student's username in the log file. The number of times each student accessed a type of pedagogical content resource is then counted, thereby allowing us to analyze patterns of resources accessed on the LMS by student. In Table 2 these measures of student usage are grouped by classification of resource type. For example, all of the variables relating to procedural content appear under the "Procedural" heading, while all content relating to online readings are grouped together under the "Reading" heading.

As presented in Table 2, some LMS resources are entirely or predominantly text oriented and static, whereas others are dynamic, multimedia, and interactive. Three of Felder's learning style dimensions, active/reflective, visual/verbal, and sensing/intuitive, are of the type reflected in the patterns of LMS recourse usage. For example, active learners should prefer using the interactive Software Tutorials more often because they can immediately apply what they have learned, while reflective learners would rather think about the material and use the resource less often. Visual learners, because they remember best what they see, should have a stronger preference towards using the multimedia/interactive content (CyberShows and Software Tutorials), while the verbal learners get more out of written words. Therefore they should prefer the reading content (Textbook Online, Topical Articles, Real World Scenarios, and Online Presentations). Sensing learners prefer learning material that is connected to the real world, they like learning facts and problem-solving methods they have been previously taught. Therefore they should prefer the Real World Scenarios, Topical Articles, Case Studies, Software Projects and Final Case Study content. Intuitive learners, on the other hand, because they dislike dealing with details, may shy away from accessing the Software Projects, Case Studies, and Final Case Study content. Consequently, the frequency that students used LMS resources serves as measures of learning styles.

TABLE 2
LMS PEDAGOGICAL CONTENT VARIABLES AND DESCRIPTIVE STATISTICS

Variable Type	Description	Hits	Mean	Median	Std. Dev.	Minimum	Maximum
Procedural							
	Syllabus	358	11.93	10.00	7.692	1	30
	Assignments	2,644	88.13	83.50	42.074	17	201
	Case Guidelines	747	24.90	23.50	13.770	6	80
	Case Studies	307	10.23	10.00	3.266	6	19
	Software Projects	1,096	36.53	33.00	19.057	12	104
	Final Case Study	144	4.80	4.00	3.960	1	23
Multimedia/Interactive							
	CyberShows	1,093	36.43	33.00	26.971	0	111
	Software Tutorials[1]	1,223	40.77	41.50	25.325	2	96
Reading							
	Textbook Online	5,213	173.77	156.00	80.214	57	329
	Topical Articles	2,038	67.93	61.50	36.046	3	167
	Real World Scenarios	217	7.23	5.00	5.137	0	19
	Online Presentations	33	1.10	0.00	2.187	0	8
Performance Outcomes							
	Student Grades	650	21.67	16.00	17.833	2	73
Total Hits							
	Total Content Hits	15,763	525.43	494.00	206.025	129	1094

[1]Total software tutorial hits (459 on LMS sever and 764 on ElementK server)

TABLE 3
SUMMARY STUDENT PERFORMANCE OUTCOMES

Performance Measures	Mean	Median	Std. Dev.	Minimum	Maximum
Case Studies	82.1	83.7	6.53	69.3	91.7
Software Projects	84.7	85.5	9.17	63.0	96.0
Final Case Study	81.2	80.5	7.61	60.4	94.3
Course Contribution	86.8	87.5	5.67	75.0	95.0
Course Average	83.2	82.6	5.36	70.9	92.5

Five measures of student performance were adopted. The grades for three case studies and two software development projects were averaged separately, resulting in two variables, Case Studies Average and Software Projects Average. The Course Contribution Grade and the Final Case Study Grade were also included as performance measure variables. The final variable, Course Average, represents a student's overall weighted average of all performance measures in the course and the final grade awarded to the student. A summary of these variables is presented in Table 3.

RESULTS

Descriptive Statistics

Table 2 reports the full set of descriptive statistics (mean, median, standard deviation, minimum, and maximum) for the thirteen LMS resource variables. Textbook Online (5,213 hits), Assignments (2,644 hits), and Topical Articles (2,213 hits) were the most widely used LMS resources, and Online Presentations (33 hits), Final Case Study (144 hits), and Real World Scenarios (217 hits) the least used. Textbook Online and Assignment Resources also showed the highest levels of usage variation. Descriptive statistics for resource usage by gender are reported in Table 4. Mean and median LMS resource usage for female

students was higher for nine of the thirteen variables, but showed lower levels of variation in usage in eight of the thirteen variables. As reported in Table 5, women also scored higher on four of the five student performance measures. Given the size of our sample, further tests of statistical differences were not conducted.

TABLE 4
LMS LOG FILE HITS - PEDAGOGICAL CONTENT BY GENDER

	Female (*n* = 11)			Male (*n* = 19)		
Content	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Syllabus	13.82	12.00	8.035	10.84	9.00	7.485
Assignments	97.55	91.00	34.343	82.68	72.00	45.949
Case Guidelines	23.73	25.00	7.938	25.58	22.00	16.406
Case Studies	9.55	9.00	2.423	10.63	11.00	3.670
Software Projects	33.27	32.00	11.279	38.42	34.00	22.453
Final Case Study	5.27	5.00	2.054	4.53	3.00	4.765
CyberShows	39.09	33.00	27.49	34.89	35.00	27.301
Software Tutorials	49.45	57.00	28.001	35.74	30.00	22.910
Textbook Online	172.64	181.00	74.536	174.42	153.00	85.315
Topical Articles	71.45	68.00	29.483	65.89	60.00	39.980
Real-World Scenarios	8.64	6.00	4.884	6.42	5.00	5.231
Online Presentations	1.64	0.00	2.767	.79	0.00	1.782
Student Grades	28.45	24.00	18.780	17.74	13.00	16.492
Total Hits	554.55	604.00	145.187	508.58	406.00	236.341

TABLE 5
STUDENT PERFORMANCE OUTCOMES BY GENDER

	Female (*n* = 11)			Male (*n* = 19)		
Content	Mean	Median	Std. Dev.	Mean	Me-dian	Std. Dev.
Case Studies	84.5	85.0	5.30	80.6	79.0	6.88
Software Projects	84.0	83.5	10.40	85.0	87.5	8.65
Final Case Study	82.2	83.9	6.55	80.7	79.7	8.27
Course Contribution	88.0	91.00	5.40	86.1	86.0	5.84
Course Average	84.4	83.4	5.11	82.6	82.4	5.36

Data Analysis

Cluster analysis of the thirteen pedagogical content variables was used to identify patterns in LMS usage. Ward's hierarchical cluster analysis was initially used to determine the number of clusters followed by K-means cluster analysis (Hair, Anderson, Tatham, & Black 1998). Cross-tabulations between the initial Wards Method and the final K-means clustering results indicated 83.3% of the students were placed in the same clusters using both methods, thus providing evidence of convergent validity (Hair et al. 1998; Morrison et al. 2003). The clustering procedures yielded four clusters, as shown in Table 6.

Examination of the variable means and medians for each cluster provides a mechanism for comparative analysis of LMS resources usage patterns. Overall, Cluster 1 has the lowest values for all variables with the exception of the Case Studies and Software Tutorials variables, while Cluster 4 is the group of heaviest users with the highest values for all variables except for Case Studies. Values for Clusters 2 and 3 primarily lie within but vary between the other two clusters.

While the mean and median values of the LMS variables assist in the initial identification of the clusters, they do not completely address all elements that require interpretation and understanding. Informa-

tion regarding the degree of dispersion of the clustering variables in each cluster allows us to assess the relative strength of each clustering variable across the four clusters, and thus provide us with richer information that can be used to interpret the four clusters. In order to assess the degree of dispersion of the clustering variables across the four clusters, we calculated a Z-Score for each clustering variable in the four clusters: Z = ((cluster mean – sample mean) / sample standard deviation). The derived Z-Scores are reported in Table 6. A graphical representation of these results provides the final step in our understanding and interpretation of the four generated online learning style clusters, as presented in Figure 2. Inspection of the Z-Score values in Table 4 and of the graph of those scores in Figure 2 reveals four distinct patterns of student behavior in accessing content on the LMS.

In the remainder of the paper, all references to the values of clustering variables refer to the mean value of that variable for a given cluster. The Z-Scores are based on these mean values, therefore, when comparing a Z-Score for one variable across clusters we are actually comparing the mean behavior of students in that cluster to the mean of the entire class or to the mean behavior of students in another cluster.

TABLE 6
CLUSTERING VARIABLE PROFILES FOR THE ONLINE LEARNING STYLE CLUSTERS

	Cluster 1 Minimalist (*n* = 12)			Cluster 2 Verbally Oriented (*n* = 8)		
Content	**Mean**	**Median**	**Z-Score**	**Mean**	**Median**	**Z-Score**
Case Studies	10.33	10.00	.031	10.88	10.00	.196
Syllabus	8.83	8.50	-.403	12.25	11.00	.041
Software Projects	33.25	28.00	-.172	29.63	30.00	-.363
Final Case Study	3.58	3.50	-.307	3.88	4.00	-.234
Case Guidelines	19.67	21.50	-.380	20.75	23.50	-.301
Assignments	53.42	50.00	-.825	93.50	91.50	.128
CyberShows	21.50	23.00	-.554	32.50	34.00	-.146
Software Tutorials	25.17	26.00	-.616	38.63	44.50	-.085
Online Presentations	.50	.00	-.274	1.63	.00	.240
Real-World Scenarios	3.33	3.50	-.759	9.75	10.00	.490
Textbook Online	102.58	100.00	-.887	258.00	254.50	1.050
Topical Articles	37.83	41.00	-.835	73.50	77.50	.154
Student Grades	15.50	13.00	-.346	24.25	18.50	.145

	Cluster 3 Visually Oriented (*n* = 7)			Cluster 4 Enthusiast (*n* = 3)		
Content	**Mean**	**Median**	**Z-Score**	**Mean**	**Median**	**Z-Score**
Case Studies	9.57	10.00	-.203	9.67	11.00	-.173
Syllabus	13.14	12.00	.157	20.67	23.00	1.135
Software Projects	38.71	36.00	.114	63.00	48.00	1.389
Final Case Study	4.86	4.00	.014	12.00	7.00	1.818
Case Guidelines	27.14	26.00	.163	51.67	48.00	1.944
Assignments	106.43	105.00	.435	170.00	167.00	1.946
CyberShows	52.57	51.00	.598	69.00	53.00	1.207
Software Tutorials	55.86	57.00	.596	73.67	73.00	1.299
Online Presentations	.86	.00	-.111	2.37	1.00	.716
Real-World Scenarios	9.71	8.00	.483	10.33	9.00	.603
Textbook Online	154.00	146.00	-.246	280.00	262.00	1.324
Topical Articles	84.57	74.00	.462	134.67	136.00	1.851
Student Grades	24.57	21.00	.163	32.67	14.00	.671

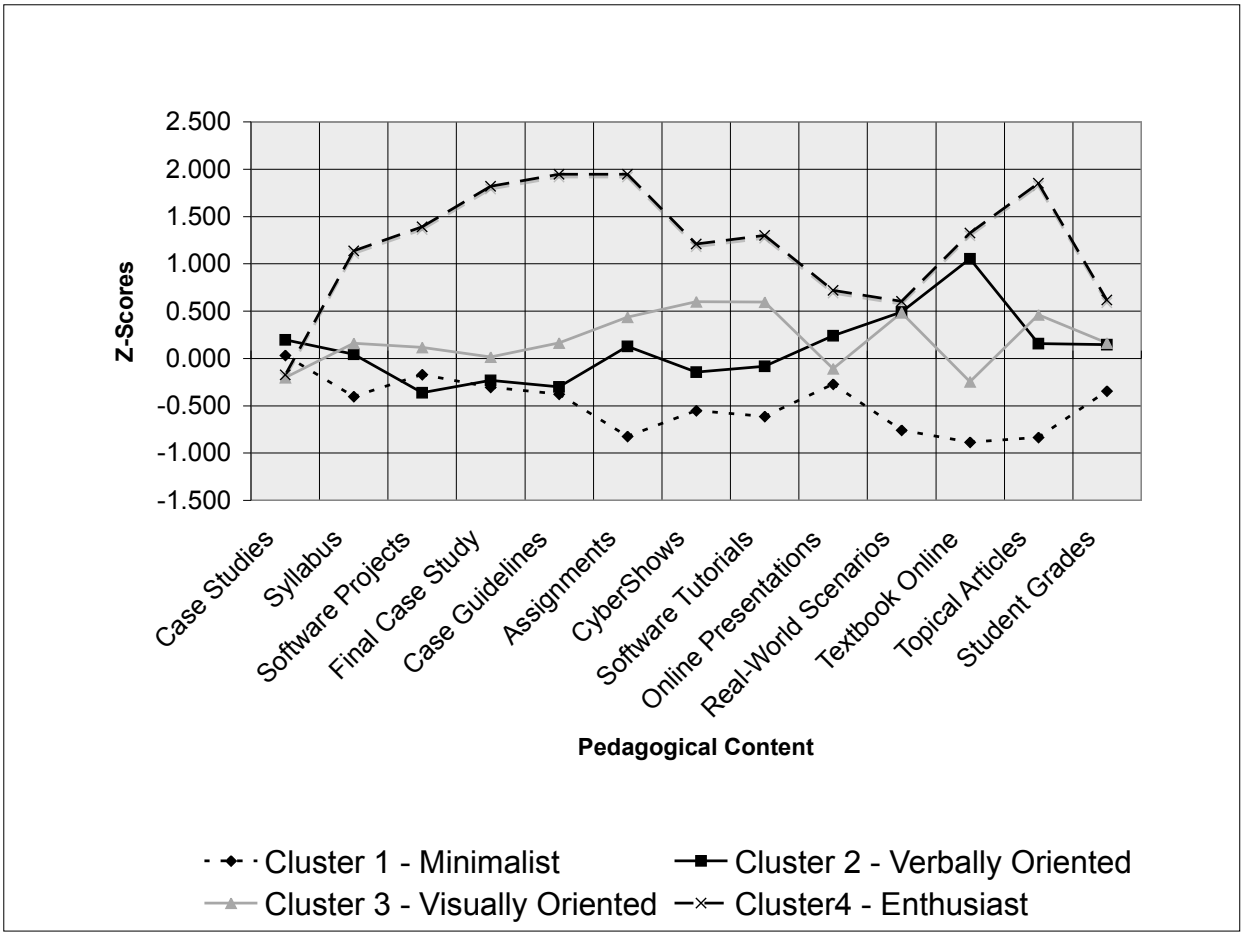


FIGURE 2
A GRAPHICAL REPRESENTATION OF THE CLUSTERING VARIABLE PROFILES USED TO FORM ONLINE LEARNING STYLE CLUSTERS

Cluster 1

On average, this group of 12 students (40% of the sample), accessed content on the LMS at a level considerably below the rest of the class. This low level of access is consistent across all four content types: Procedural, Multimedia/Interactive, Reading, and Grades. Of particular note are the large negative Z-Scores for the Assignment resource (z = -.825), which is the entry point for many other resources, as well as the three main reading resources (Real World Scenarios (z = -.759), Textbook Online (z = -.887), Topical Articles (z = -.835)). Grades for this cluster are lowest on three of the five performance measures, including overall Course Average (see Table 7).

Cluster 2

The eight students (26.7% of the sample) in this group accessed Procedural and Multimedia/Interactive resources slightly less than the mean of the entire class. However, they accessed Reading content more frequently than the mean level for the entire class. Of particular interest is their high level of access for the Textbook Online (z = 1.05). These students checked their grades slightly more than the mean for the entire class, but less than those students in Clusters 3 and 4. This cluster had the highest grades on two of the performance measures, including overall Course Average.

Cluster 3

The pattern of resource usage for the seven students (23.3% of the sample) that comprise this cluster shows that they accessed seven of the eight Procedural and Multimedia/ Interactive resources more fre-

quently than the students in clusters 1 and 2, with especially high levels of access for Multimedia/Interactive content. In contrast, this cluster accessed three of the four Reading resources at lower levels than Cluster 2. Finally, the students in this group checked their grades more frequently than those in Cluster 1 and slightly more frequently than those in Cluster 2, but less often than those in Cluster 4. Grades for this cluster are lowest on the Final Case Study but highest on Software Projects.

Cluster 4

The cluster analysis assigned three students (10% of the sample) to Cluster 4. As the graph in Figure 2 clearly shows these students accessed all but one of the Procedural resources more frequently than one standard deviation from the class mean, with the level of access for the Final Case Study, Case Guidelines, and Assignments approaching two standard deviations. Similarly, they accessed Multimedia/Interactive and Reading content more frequently than those in the other three clusters. This group also checked their grades more frequently than any other cluster. This cluster had the lowest grade for the Software Project but the highest for Class Contribution and the Final Case Study.

TABLE 7
STUDENT PERFORMANCE OUTCOMES BY CLUSTER

	Cluster 1 Minimalist (*n* = 12)			Cluster 2 Verbally Oriented (*n* = 8)		
Outcome	**Mean**	**Median**	**Std. Dev.**	**Mean**	**Median**	**Std. Dev.**
Case Studies	80.73	80.70	6.912	83.45	84.65	5.32
Software Projects	83.17	86.50	9.678	86.50	85.50	6.824
Final Case Study	81.64	79.98	7.414	81.09	81.18	6.868
Course Contribution	85.58	85.50	6.288	87.50	88.00	4.840
Course Average	82.27	81.38	5.484	84.29	82.70	3.422

	Cluster 3 Visually Oriented (*n* = 7)			Cluster 4 Enthusiast (*n* = 3)		
Outcome	**Mean**	**Median**	**Std. Dev.**	**Mean**	**Median**	**Std. Dev.**
Case Studies	82.43	83.70	7.372	82.87	85.30	8.611
Software Projects	85.79	88.50	11.499	83.00	77.00	10.392
Final Case Study	79.97	83.89	9.927	83.08	80.75	8.009
Course Contribution	86.71	87.00	6.130	89.67	90.00	5.508
Course Average	83.36	83.32	6.717	83.98	82.92	7.998

Analysis of Clusters

The distribution of gender differences across the clusters is reported in Table 8. There were no female students in Cluster 4 and only two of twelve (16.7%) in Cluster 1. Women comprised half (50%) of the students in Cluster 2 and five of seven (81.8%) students in Cluster 3. In sum, 81.8% of all females in the sample were members of Clusters 2 and 3.

Overall, evidence from the cluster analysis and the Z-Scores graph suggests that differences in online learning styles in student LMS usage. As indicated by the graph of Cluster 1's variables in Figure 2, the students in Cluster 1 had the lowest frequency of usage for almost all of the LMS resources, which provides the label for this cluster as "Minimalist." Indeed, on those important items that normally require

TABLE 8
CLUSTER DEMOGRAPHIC DISTRIBUTION

	Gender	
Cluster	**Female (*n* = 11)**	**Male (*n* = 19)**
1 – Minimalist		
Count	2	10
% Within Cluster	16.7	83.3
% Within Column	18.2	52.6
Expected Count	4.4	7.6
2 – Verbally Oriented		
Count	4	4
% Within Cluster	50.0	50.0
% Within Column	36.4	21.1
Expected Count	2.9	5.1
3 – Visually Oriented		
Count	5	2
% Within Cluster	71.4	28.6
% Within Column	45.5	10.5
Expected Count	2.6	4.4
4 – Enthusiast		
Count	0	3
% Within Cluster	0.0	100.0
% Within Column	0.0	15.8
Expected Count	1.1	1.9

continual access by students throughout the entire semester, such as Assignments, Textbook Online, and Topical Areas, the students in this cluster had the lowest frequency. Several different scenarios possibly explain this behavior. First, the students in this cluster may be a type of technologically averse student. Rather than accessing online resources on a regular basis, it is possible that these students may be printing out the content, filing it, and using hard copy in a more traditional manner. Similarly, since the results indicate that these students accessed the Multimedia/Interactive content considerably less than students in the other three clusters, these students may have been gaining the relevant information from traditional face-to-face classroom instruction. Overall, this pattern may represent a reflective, verbally oriented learning style that did not fit with the emphasis on technology embedded in the teaching style of the instructor. It may be that an objectivist, teaching-centered style would have been more consistent with the learning styles of the students in this group. Alternatively, these students may simply have been unmotivated, and regardless of the instructor's teaching style, their online activity would lag. The grade performance of this group was notably lowest in three of the five categories including Course Grade.

The students in clusters 2 and 3 exhibited similar behavior when accessing the Procedural and Performance Outcome resources but divergent patterns for Multimedia/Interactive and Reading content. Both clusters were relatively close to the class mean for Procedural and Performance Outcome resources, indicating a pragmatic approach to this content. However, for Multimedia/Interactive content, Cluster 2's frequency of access is slightly below the course mean, while Cluster 3's is well above the class mean. Based on Felder's visual/verbal dimension, this suggests that the students in Cluster 3 may be more visually oriented learners and those in Cluster 2 more verbally oriented. When Reading content is considered, the clusters diverge in opposite directions, thereby affirming these visual and verbal orientations. Overall, Cluster 2 students access text-based reading content more frequently than the Cluster 3 students. The divergence is most extreme in the Textbook Online content, which constitutes the bulk of the assigned reading for the course. Cluster 2 students accessed the online textbook content far more frequently than the students in Cluster 3, who accessed the online textbook content less than the course mean. This supports

the interpretation that the reading preference of the Cluster 2 students indicates verbal orientation as explained by Felder. Accordingly, good descriptive labels for clusters 2 and 3 would be "Verbally Oriented" and "Visually Oriented," respectively. The interaction of the learning styles of these students indicates fit with some but not all elements of the instructor's teaching style.

The usage pattern of the students in Cluster 4 showed that they enthusiastically embraced all of the LMS technology. Their frequency of accessing the Multimedia/Interactive materials suggests active learners comfortable with visual as well as verbal resources. They also appear to be very comfortable with reading the reading assignments online. Accordingly, an appropriate descriptive label for Cluster 4 would be "Enthusiast." Overall, there are to be four distinct patterns of usage that appear to represent four distinct online learning styles.

DISCUSSION

Limitations and Future Research

Before we discuss the interpretation of our findings in this exploratory study, we must include three notable limitations. First, the sample size employed here limits our ability to conduct tests of statistical differences and the generalizability of our findings. We knowingly accepted this limitation in order to take advantage of the opportunity to examine a rich and unique data set. This information not only allowed us to test previously published findings regarding the effects of gender, it also allowed us to begin to examine new questions surrounding learning styles that has not been addressed in the business education literature. Clearly, use of larger samples in future research would test some of the conclusions we have drawn here as well as also provide a basis to apply more robust statistical analyses.

Related to this limitation are the effects of our sample being drawn from a single discipline at a single institution taught by a single instructor, which is common in prior education research in this area (Arbaugh & Stelzer 2003). The students in the sample were all traditional, full-time students attending a highly-selective, residential, private undergraduate institution. Extending these findings to broader educational settings is clearly a necessary development for future work.

Finally, our findings are constrained by the fact that we were looking for patterns of technology usage as they developed in reaction to a single teaching style used in a hybrid course. The resource usage patterns comprising the online learning styles evidenced here, may not be the same type that would be that reflected when interacting with other teaching styles or in completely online courses. Future research would benefit from the measurement of the teaching styles of multiple instructors or comparing styles in hybrid versus online courses.

Conclusions

Based on the results discussed above, we can begin to answer our two primary research questions regarding how students use online course resources and what effect this usage has on student learning. We found initial signs of differences in patterns in the actual usage of the instructional technologies. These patterns indicate the potential existence of online learning styles and differences in the online learning styles of women and men. In essence, learning styles matter.

This conclusion has several implications. First, consistent with Arbaugh's early (2000a) and recent (2005b) research, our work shows that gender should be taken into account in the empirical investigation of instructional technology in business education, as it appears that they used instructional technology differently than men. Furthermore, when online learning styles are considered, some women were found to be more active and visually oriented than others. This finding that not all women used online resources the same way represents a new contribution to the research in this area and represents a potentially worthy direction for future research.

Recognizing learning style differences is the first step for instructors seeking appropriate teaching methods (Brokaw & Merz 2000). While some have recommended that instructors should modify their teaching styles to accommodate the wide variety of student learning preferences (De Vita 2001; Felder 1993), instructional technologies such as LMS offer supplemental mechanisms by which instructors may be able to address a wider variety of instructional needs. Individual instructors unwilling to adapt well-established and successful personal classroom teaching styles may find that the development of new uses for instructional technologies offers a means of responding to previously overlooked learning styles. Accordingly, rather than a simple additional static channel facilitating course delivery, instructional technologies such as LMS represent an alternative means to increase consistency between student learning style and instructor teaching style and thereby improve student learning.

The second implication of this study is that we have applied a methodology that distinguishes this study from prior research of instructional technology in business education. We used a new source and type of primary data to examine student usage of online instructional technologies. Prior research focusing on student learning has relied almost exclusively on self-report data of student learning preferences collected through surveys. While a great deal has been learned from this type of data, server data provides complementary evidence of actual usage of instructional technologies over an extended period of time. This direct information can serve to overcome some of the methodological problems associated with self-reported and perceptual measures. Future research combining self-report and direct usage data would provide a fuller picture of student learning.

Finally, a necessary means to getting this new source of data, and the final contribution of this exploratory study, is the development and application of the methodology to collect, process, analyze, and interpret Web log data. While this process has been initially developed and applied in other fields, it can be applied regardless of pedagogy, discipline, or institution. From a teaching perspective, management educators and instructors have a new assessment process that provides a protocol that can be used to determine online learning profiles and evaluate the effectiveness of LMS technologies relative to those profiles.

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