

Mining the Internet to Discover Learning Management Systems popularity: Evaluating Who is on Top and Why

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Abstract—Our research reports new data on learning management system (LMS) popularity and gives an evaluation based on feature availability and ease of use of the four leading LMS platforms utilized in US higher education institutions: Canvas, Blackboard, D2L and Moodle. This research provides both the methods to mine market share and links to the data from our mining activities. The analysis breaks down possible reasons why we find such a strong front runner in Canvas. The research compares each feature of the four top LMS platforms and their ease of use. The aggregated data provides a usability score based on the presence of each feature and a ranking of the time it took an instructor to implement the feature. We also review the critical elements of Accessibility and Documentation.

Index Terms—data mining, HCI

I. INTRODUCTION

Mining data often answers the question of what, but not always why. Our discovery that Canvas has gained a substantial market-share lead over other learning management systems (LMS) in the USA, prompted this report of that discovery and a review of possible reasons why. This research includes the data mining techniques and links to data along with the evaluation methods used to discover why, in such a mature area where the top four own 95% of the market share in the USA, Canvas somehow dominates with 58% of the total market share. The question we examine is simply, who is on top and why.

Bush [1] defines an LMS as “a software application or web-based technology used to plan, implement and assess a course.” Typically these systems contain links to all content pertinent to a course broadly grouped into either resources or activities. Most LMS platforms are selected and maintained by the school so as to provide a common appearance across all classes. Schools expect teachers to utilize the LMS thereby giving each student access to all pertinent course information across all courses for that student in a single place, with a consistent look and feel.

Past research has focused on their use in asynchronous or distance education [2]–[4], and what they should be or should not be [2], [5], [6]. For a nice history of MOOCs and

their demise followed by the mega-university phenomenon we recommend Feldstein [7].

In 2016, Kasim and Khalid [8] reviewed learning management systems with the goal of choosing the right LMS platform for higher education. Of the systems discussed in their paper, three overlap the most popular LMS platforms in the US in 2023. We review the top 95% of all LMS platforms in use in the USA, which represents only four LMS platforms total. Among those four it is not difficult to distinguish the winner by popularity if not by features.

Others have also reviewed LMS platforms, but with the fast pace of technology, this information quickly becomes irrelevant. Evaluations of LMS platforms also appear rare in research. Indeed Kasim and Khalid [8] gave the latest direct, holistic evaluation of LMS platforms we could find in peer reviewed materials.

This evaluation uses the perspective of the instructor or course designer. But why? Why not the student, administrator or some other perspective? The answer is quite simple, if an instructor has trouble using the features of the required LMS platform, everyone else will suffer the consequences of their not utilizing the tools effectively or at all.

We present this research by defining our research methodology in Section II followed by our data mining results for the most popular LMS platforms in the USA. Section IV reveals our research results on the features and ease of use ranking. Section V discusses the importance of compliance in accessibility and the level of compliance you can expect from the four platforms we review. No review from the perspective of an instructor or course designer would be complete without an evaluation of the documentation, which we provide in Section VI. Finally, Section VII provides conclusions and future work.

II. RESEARCH METHODOLOGY

The mining research is a straightforward review of the college and university websites. The evaluation research covers two important qualities of LMS platforms. First, available features determine how fit an LMS platform is for duty in

higher education. Second, ease of use determines how likely course creators are to use those features.

A. Data Mining LMS Platforms

Our Python program used Selenium [9] to mine from a list of four year colleges and universities [10]. Our goal was to mine without disturbing or taxing the websites. To accomplish this, the script randomly added time between requests to the same servers. Links from the homepage of each institution were gathered and evaluated using keywords for the likelihood that the link would go to an LMS system. If the link was in the same domain and it had a promising keyword, that link was explored. Links indicating an LMS were used to determine the LMS for a school.

B. Feature Evaluation

For each feature in the four reviewed LMS platforms the authors tested the feature on the current platforms available (as of Jan-2023) by creating and using the features listed. Scores on a 1-5 point scale were given based on the rubric show in Table I. Note that these are mature platforms and that we should expect 4's and 5's to be the norm. Configuration options is almost always the defining difference between platforms. In the case of all 5s when evaluating criteria, you can expect features to be almost identical in options and ease of use. Occasionally, one option would be available on only one platform, and this was not considered against the other platforms. E.g. Blackboard was the only platform that provides an option that requires 2 graders on an assignment.

We also timed the testing session to see how long it takes to complete an activity setup. The time itself is relative to the user, so we report a ranking of each feature from fastest to slowest.

The tests did not explore every aspect of the feature. E.g. There is no analysis of originality scores that show how effectively this aspect performed. We did check to see if it was present and could be used and how easily it was to implement.

The evaluation also recognizes that each feature may not be named the same thing across LMS platforms or that an element integrated into one feature may be available as a separate feature. E.g. Moodle has a separate TurnItIn assignment type instead of a setting to integrate TurnItIn into the assignment activity.

We note also that the four evaluated LMS platforms are mature systems that have been around for many years. Consequently our expectation is that the feature list should be nearly identical in functionality if not in name.

C. Ease of Use

When it comes to aesthetics and ease of use, people vary widely on their opinions about quality measures because these opinions are based on experience and that experience informs their intuition [11]. In the area of Human Computer Interaction (HCI), we find that creating "intuitive" user interfaces requires strongly user-centered design, and thus ties that design to the users goals and intentions [12]. Further we propose that if

intuition does not provide a way toward a user's goal in a short period of time, then it is not intuitive and may be perceived as not easy to use. Hence, we arrive at an idea of how to measure ease of use for users who regularly use the system: how many steps does it take to complete the setup of the feature in question. This is just one dimension from the USE Questionnaire [13]. We give a score for this dimension based on our experience using the different features. A complete usability study is left as future work.

III. MINING LMS INFORMATION

To determine market shares of the top LMS platforms, we mined 2132 four-year institutions in the US [10]. Of those four-year institutions, 1654 identified the LMS used in that institution on their website. Figure 1 shows the results of our data mining. These top 5 represent approximately 98% of the market share, leaving 2% to other LMS platforms.

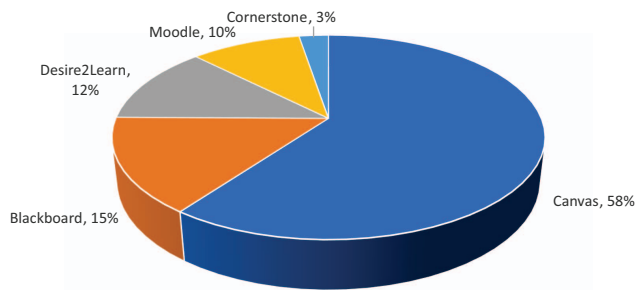


Fig. 1. Distribution of LMS software in use by US four year higher education institutions.

This is a significant shift from data for North American higher education institutions reported by Menard [14] which shows Canvas leveling out at 35% in 2022.

For those interested in the data or the mining programs please contact the authors.

IV. FEATURE EVALUATION RESULTS

Since LMS platforms became popular, the builtin tools have both proliferated and fragmented into many tools. We break the tools provided by LMS platforms into the following categories: student work activities, communication/response activities, content creation activities, resources, and packaged/external content.

For each of these categories, we give a general description of each tool. Tables II-VI then provide a comparison and note unique features.

In general, each LMS has its own style and paradigm for navigation and organization of information, but each system provides similar functionality. The first distinguishing characteristic that divides the LMS platforms is navigation: scrolling or clicking.

Scrolling Hell, as we call it, is when a user must scroll to a distant location on a page after clicking on a link. Naturally, every platform provides a way to avoid this problem, but some force you into avoiding it, and others just provide a way to

TABLE I
CRITERIA FOR EVALUATING FEATURES OF LMS PLATFORMS.

Criteria	1	2	3	4	5
Feature & configuration options	Feature is missing	Some basic configuration options of the feature are missing	All required configuration options are present, but require excessive scrolling or clicks	All required configuration options are present and easy to use: few clicks and little scrolling	All required options and additional options are present and easy to use: few clicks and little scrolling

avoid it. Where LMS platforms fall prey to this behavior, we note it below. Organization of information is also reviewed on a platform-by-platform basis.

Canvas contains common elements of the interface in left edge tabs. Each tab may contain a vertical list of links for that tab and may be context aware. Teachers get to pick what is on the courses tab, but the most important one for students is the “Modules” link. Modules shows the content of the course in the order created by the instructor. One naturally works from top to bottom. Modules, when minimized, should fit on one page, and everything within a module is usually visible. Its then easy for a student to click on a module and start working. Elements here are simple and take up little space which allows you to pack more onto the page so that there is little need to scroll. This provides a good balance between clicking and scrolling. This simple and intuitive interface has helped to make Canvas the top LMS in the US.

Blackboard also contains common elements of the interface in left edge tabs. Each tab, except for the courses tab, brings up a different page. But here the similarities end. When you click on a course, it pulls out a nearly full screen overlay page that nearly covers the left edge tabs - and those tabs are no longer clickable, so the space is wasted. Across the top of this pullout, you have several page tabs for the course. Each page is uniquely designed for the content that it holds. The “course content” page is where students will likely spend most of their time. Similar to canvas, it contains “Folders” to organize content. Once you get used to the odd pullout pages, Blackboard is quite intuitive to use. Its features however, are large and take up lots of space. This will increase scrolling on a page making it easier for a student to lose their place.

In many ways Canvas and Blackboard share similarities in their interfaces. There is no edit mode, such as provided in Moodle. Instead each feature is edited in place (Canvas) or with a pop-out page (Blackboard). Clearly people prefer Canvas in the US, but it may not be solely based on their slightly better interface.

D2L BrightSpace appears modeled after WordPress, a more traditional content management system. It has a header and a menu bar across the top and content down the middle, and the left side provides helpful links to content. Like Blackboard, its features are quite large and take up a bit of vertical space on the screen. Students will be scrolling once you create a few items on the page, but D2L does provide Modules that equate to pages on the “Table of Contents” and “Sub-Modules” within pages to organize content within each module. This provides

a great way to organize content if the course designer takes advantage of this feature. Editing elements is extremely easy in D2L. As a slightly more complex system, it takes some time to find where everything is and the best way to organize it.

The latest version of Moodle has changed the look of their features to be “cards”, including a large icon and two lines of text. Further gobbling up space, the features with open/due dates also include this information in an additional two lines below the large icon. In my sample course this allowed only four features (a forum, a survey, an assignment, and a file resource that went with the assignment) visible on a standard 1080P screen. A dynamic table of contents litters the left side of the screen and “Blocks” that provide information and content run down the right side of the screen. The Blocks, at least, are editable. Moodle allows you to organize content in several ways: Single activity, social, weekly, and topics. Never-the-less, these still all sit on the same page. Your students will be scrolling, unless the teacher pro-actively hides sections or creates pages of content that are linked on your course page. However, hiding content also blocks access to the content, so this is problematic. Moodle has lots of plugins and modifications so that one can usually work out a reasonably decent experience for their students and teachers. In terms of variety, they are unrivaled. But, alas, they are last on our list in popularity and the interface may have something to do with that.

LMS features naturally divide into the following types:

- Student Work Activities (Section IV-A)
- Communication Activities (Section IV-B)
- Content Creation Activities (Section IV-C)
- Embedded Resources (Section IV-D)
- External Resources (Section IV-E)

In Section IV-F, Table VII shows summary results of criteria used to evaluate each feature as discussed in Section II.

A. Student work Activities

Student work activities encompass those shown in Table II. Although some platforms allow grading of almost any type of activity, these activities traditionally require grades and form the core assessment found in the grade book.

Assignments provide a place for students to upload artifacts and a place for teachers to grade and give feedback for both online and offline assignments. This means that if a teacher requires students to turn in a physical paper copy, the results can still be recorded and materials returned online with

appropriate feedback. Assignments may apply to a group or an individual and some form of TurnItIn or similar originality checking is available on each of the platforms reviewed. Each assignment may also be associated with a rubric, enforce release conditions, and allow blind or anonymous grading. As you would expect, the capabilities of the top four are nearly identical in features. In this case we tested a simple assignment that had a word document containing directions and a place to upload the completed project.

Quizzes provide both auto-graded objective questions and manually graded subjective questions. Objective questions include multiple choice, fill-in the blank, short answer, numerical, true/false, matching and more. In total Moodle has 16 question types, Canvas and D2L both have 11, and Blackboard has 10 [15]–[18]. These do not include plug-ins that may add additional question types and some questions may show up as two different types. One example of that would be “fill-in the blank” vs. “fill-in the blanks” listed as separate question types. Standard options include shuffle answers, time limits, review options (e.g. show answers after completion etc.), one question at a time, require access code, and due/availability dates. In testing this feature, we created multiple choice, true/false, matching, fill in multiple blanks, numeric or calculated questions. Although Moodle caused the biggest delay in creating questions, due to the system reaching an error state while creating the calculated answer question, it does have more options than any other platforms.

Peer assessment activities provide the ability to have your students perform peer assessments. Canvas and BlackBoard both include an option in the assignments feature to turn on peer reviews. Moodle has a separate assignment type, called Workshop, for peer reviewed work. Oddly BrightSpace displays no clear way to have peer reviewed assignments by default. But, BrightSpace does partner with Bongo [19], [20] to provide individual project, group project, Q&A and interactive video peer review activities. In general, once work is handed in, the work is distributed back to students to assess based on a grading scale specified by the teachers.

Adaptive learning activities provide teachers an activity to create ‘branching’ exercises where students are presented with content and then, depending on their responses, are directed to specific pages. This is still an emerging field and concepts can be quite diverse from one platform to another.

Canvas uses something that they call “master paths,” which is essentially a map of ways through a set of activities and content based on the student’s performance at each step. If the teacher configures the paths to allow “or” choices, then students choose their path at those points. Otherwise, “and” requires a student to follow a strict path. For example, we can have a review quiz where students who score 80% or higher can go directly to the exam or complete an additional review assignment and then take the exam. But students who score below 80% must do both. This is not adaptive in the sense that we cannot create paths through a quiz or test questions. For a nice demo see Suzy Lolley’s video [21].

BlackBoard has a feature named “Adaptive Release” that

is similar to the Canvas approach. In Blackboard this tool has to be installed/enabled for you to use it, and it was not enabled on the trial. We used CUT eLearning and Educational Technology’s video [22] to determine a score for this task.

D2L provides a more holistic approach to adaptive learning, one part of which they call “Custom Learning Paths” implemented through release conditions [23]. When working through this example, D2L was by far the easiest and most intuitive.

Moodle provides both an adaptive release restriction for assignments and a Lesson assignment that can have branching questions and other unlimited content. The adaptive release functionality works nearly identically to Canvas and BlackBoard. The Lesson activity is extremely flexible, easy to create and provides a feature not available by default in any other platform.

TABLE II
COMPARISON OF LMS: STUDENT WORK ACTIVITIES.

Features	Canvas	Blackboard	D2L	Moodle
Assignment	5	5	4	5
Quiz	5	5	4	3
Peer Assessment	5	5	1 ¹	3
Adaptive Learning	4 ²	4 ²	3 ²	5
Mean Scores	4.75	4.75	3.00	4.00

1. Requires a plug-in
2. Only in paths through activities and content, not through an assignment or quiz questions

Ranking based on time for all student work activities gave the following ordering based on the research methodology from Section II.

- 1) Canvas
- 2) Blackboard
- 3) Desire2Learn
- 4) Moodle

B. Communication Activities

Student communication activities encompass those shown in Table III. Although some platforms allow grading of almost any type of activity, these activities traditionally do not require grades and yet instructors may wish to provide some sort of participation credit in the grade book.

The first four tools we consider have been around since the millennium started, so features here are at near parity and act just as any generation that has used a computer would expect them to act.

Messages=Inbox=Email: Most platforms integrate with email directly into the application or provide a way for the platform’s messaging system to send notifications through email. Whatever the pleasure of the institution, messaging provides all the expected features of email and every platform provides a similar experience.

Announcements: When teachers got tired of emailing individual or group listservs, developers came up with Announcements. They work as expected, spamming student inboxes with information that instructors absolutely expect students to read.

Plus, the LMS keeps a record of the announcements within the platform so that after the student deletes the email, they can go back and read what they missed in the LMS. All platforms provide this functionality and couple it with release conditions so that instructors can schedule the release of information.

Discussion/Forum activities provide a place for students to post and respond to questions. Since this type of communication dates back to the beginning of LMS platforms, each platform contains some sort of discussion/forum tool that allows students and teachers to post and respond to questions at any time.

Calendar tools show due dates and other important appointments, such as class times, in a traditional calendar format that can show day, week, and month formats. For simplicity, users may restrict the calendar to the class they are viewing.

Chat tools are almost extinct with the advent of more complex face-to-face communication tools being supported by the internet. However, most platforms do provide a live chat. Canvas provides this but it is not enabled by default. Blackboard provides this through their collaboration environment discussed next. Both Desire2Learn and Moodle provide this basic tool by default.

Collaboration: Blackboard Collaborate provides a live collaborative work environment that integrates real-time communication, file sharing, whiteboard, screen/application sharing, polling and breakout groups all together and available through any computing device. To provide real-time collaboration similar to Blackboard, most platforms integrate BigBlueButton [24]. Canvas calls this conferences and integrates it right into the platform. Desire2Learn includes it through LTI, and Moodle includes it by default, but it must be configured and enabled. Many students already collaborate similar to this using Google Docs in combination with Zoom or some other tool.

In terms of collaboration on documents, most of the platforms add integration with Google Docs and/or Office 365. In some cases, this happens concurrently with live communication activities. Canvas and Moodle provide plugin or LTI integration for these collaboration tools. But all platforms find a way to make these collaborative activities available.

Table III shows that, in communication features, the platforms are at near parity. The main difference is in setup and default availability. Here Blackboard shines, with Canvas just keeping up, while Desire2Learn and Moodle fall a bit behind.

TABLE III
COMPARISON OF LMS COMMUNICATION/RESPONSE ACTIVITIES.

Features	Canvas	Blackboard	D2L	Moodle
Expected ¹	5	5	5	5
Live Collaboration	5	5	4	4
Office Integration	5	5	4	4
Mean Scores	5.00	5.00	4.33	4.33

¹textitl. Includes: Messaging (email), Announcements, Discussion Forums, Calendar and Chat

Time ranking for all communication activities gave the following ordering based on the research methodology from

Section II. It is not a coincidence that this stayed the same as the student work section.

- 1) Canvas
- 2) Blackboard
- 3) Desire2Learn
- 4) Moodle

C. Content Creation Activities

Content creation covers those activities which require students to create content within a framework provided by the LMS. These include journals/blogs, HTML content, Wikis, glossary and rarely but interestingly a database on Moodle.

Journal/Blog: Although a bit outdated, one would expect this type of content creation to be ubiquitous, but it is not. Canvas, Blackboard and Desire2Learn all co-opt the Discussion activity to be used as a journal or blog. Moodle used to provide this by default, but now it is a plugin that must be enabled. As a consequence, all of the platforms took a hit on the score in this category. We note that discussion would certainly be appropriate for a blog in most cases, but, for a journal, it is most certainly not. Suppose a student is required to journal their participation in a support group. Discussions are open, and these would most definitely need to be private. Even in the case where Discussions are made private, the activity will look and be named something that a student will recognize as an open discussion.

HTML Page: Canvas calls this pages, blackboard a document, Desire2Learn a File and Moodle a Page, but they all do the same thing: allow you to create an HTML fragment that is then displayed. Each platform allows you to easily assign students to create these HTML fragments.

Wikis: Canvas says to use [HTML] Pages in place of wikis. This does not work because Pages does not show edit history. Blackboard's new Ultra experience cuts this out completely and instead recommends OneDrive, OneNote, Google sites, Weebly or a dedicated wiki tool available elsewhere [25]. Desire2Learn also does not include a wiki and instead, the brightspace community board recommends using Google Docs or Office 365 OneNote [26]. Moodle still has a wiki that can be collaborative or individual.

Glossary: Almost all the platforms reviewed gloss right over this and assume that you will use a standard assignment for creating Glossaries. This could be a standard assignment or an integration with Google Docs and Office 365. Moodle is the only one that provides a framework for creating individual and collaborative glossaries, and it provides a nice and intuitive activity. It allows participants to create and maintain a list of definitions or it can be used only by the teacher or as a collaborative exercise. Most impressively, the Glossary auto-linking filter will highlight any word in the course which is located in the Glossary.

Database: Whoever heard of a database being included as a learning tool on an LMS? Moodle does excel at providing esoteric tools and specific activities that have unique elements instead of suggesting that the instructor use an existing tool that approximates the activity required. The Database activity

is just such a tool. It provides a way to create database tables and to use forms to fill those tables. It is quite unique among the different content creation tools. We did not deem it necessary to lower the score for the other platforms because they lack such a tool. Instead we note that an instructor could simply ask the students to create a SQLite database and turn that in. Consequently, this tool is not included in the ratings.

Table IV shows that Moodle provides more options for content creation than any other platform. The rest show near parity on their features.

TABLE IV
COMPARISON OF LMS CONTENT CREATION ACTIVITIES.

Features	Canvas	Blackboard	D2L	Moodle
Blog/Journal	3	3	3	5
HTMLPage	5	5	5	5
Wiki	4	4	4	5
Glossary	4	4	4	5
Mean Scores	3.75	3.75	3.37	5

Ranking based on time for all communication activities gave the following ordering based on the research methodology from Section II. Interestingly, it was easier to identify and setup the different activities native to Moodle than the other platforms. Outside of Moodle, the times in each platform were relatively close.

- 1) Moodle
- 2) Canvas and Desire2Learn (tied)
- 3) Blackboard

D. Embedded Resource Capabilities

Embedded resources include those resources usually placed in the LMS by the instructor for students to download or to view as information. These include files and folders, additional text and media, links, and pages. Because it took more than a few seconds to create an item in previous categories, we run up against a time issue that was heretofore unnoticed. Moodle always requires you to “turn on editing” every time you start editing content. Here, that time was enough to notice in Moodle. If there was a way to automatically enter edit mode for teachers, or to set it in a profile setting, we could ignore this, but we could not.

Files and Folders: The folder displays several course files together. They may be uploaded all together as a zipped folder, or added one at a time. Canvas provides easy drag and drop functionality for files and folders and gives you the option to unzip a zipped file. Blackboard also uses drag and drop, but in this case right into content. It is easy and simple but it does not offer to create a folder and unzip the contents for zipped files. This is easy in Desire2Learn as well, but not as easy as either Canvas or blackboard because you have to push the upload link before you drag and drop your file or folder. Moodle also provides easy drag and drop functionality for both files and zipped folders. However, one cannot centrally manage those files and folders.

Text and Media: Also known as a Label, the Text and media area serves as a spacer on a course page. It adds text, images

or multimedia in between other resources. These are similar in nature to creating a page and is equally easy in all four platforms.

URLs: URL resources provide a link to other content in or out of the LMS. In all platforms this was easy, but not all were equally easy. Desire2Learn required an extra click and doesn’t have the ability to add a description.

Pages: A page resource creates a link to a screen that displays the content created by the teacher separately from the rest of the content. Every platform has this ability and in each case they were equally easy to implement.

Moodle has the ability to break pages down even further and provides the Book activity. It allows teachers to create multi-page, multi-chapter resources with a book-like format and table of contents. Books may include embedded Multimedia, and be exported into a printable format. There appears to be limited use for this, so we did not count it in the overall scores.

Creating resources turned out to be extremely close in time. Apart from extra clicks, these actions were surprisingly similar given the diversity in some other areas. Therefore we have a 2-way tie for first with the extra clicks creating the time difference in 2nd and 3rd place as shown below.

- 1) Canvas & Blackboard
- 2) Desire2Learn
- 3) Moodle

TABLE V
COMPARISON OF LMS RESOURCES.

Features	Canvas	Blackboard	D2L	Moodle
Files & Folder	5	4	4	4
Text & Media	5	5	5	5
URLs	5	5	4	5
Pages	5	5	5	5
Mean Scores	5	4.75	4.5	4.75

E. External Resource capabilities

External resources include content that comes from external sources such as LTI integrations, H5P packages, SCORM packages and importing content from IMS Common Content Packages. In this section we will review the abilities of platforms to accept and interact with these external resources.

In fact, each platform provides a way to integrate LTI and SCORM as well as being able to import/export IMS Common Content Packages. However the Canvas SCORM capability was disabled in their free test environment. H5P provided the only other differentiating factor for these in that Moodle natively supports H5P packaged content, while all the others use LTI integration. Table VI shows the nearly identical scores for these platforms.

Timing for LTI was not relevant since we were not able to integrate LTI without some additional setup that was not accessible on the free test platforms. For the other features, we had a two way tie for first, followed by a two way tie for second.

- 1) Blackboard & Desire2Learn
- 2) Canvas & Moodle

TABLE VI
COMPARISON OF LMS PACKAGED/EXTERNAL CONTENT.

Features	Canvas	Blackboard	D2L	Moodle
SCORM	N/A	5	5	5
IMS Content Package	5	5	5	5
LTI®	5	5	5	5
HSP	4	4	4	5
Mean Scores	4.75	4.75	4.75	5

F. Summary of Feature Comparisons

In most cases timing of the task was close between systems, with D2L and Moodle consistently working the mouse more for both scrolling and clicking. Moodle seems to be the most complex and visually difficult to navigate and probably accounts for its decline in popularity. Table VII shows the overall results follow closely the popularity order seen in Figure 1.

TABLE VII
SUMMARY RESULTS OF LMS ACTIVITY TYPES.

Activity Type	Canvas	Blackboard	D2L	Moodle
Student Work	4.75	4.75	3.00	4.00
Communication	4.80	4.60	4.00	4.40
Content Creation	4.00	4.00	4.00	4.75
Embedded Resources	5.00	4.80	4.60	4.60
External Content	4.75	4.75	4.75	5.0
Aggregate Scores	4.66	4.58	4.07	4.55

V. LMS ACCESSIBILITY FEATURE COMPARISONS

Since 1996, the department of justice has consistently taken the position that ADA applies to web content. This was applied to learning management systems in 2016 when the United States filed a lawsuit alleging that Miami University discriminated against students with disabilities by providing inaccessible web content through their learning management systems [27], [28]. Consequently, Accessibility is an important component that every LMS platform must provide. Each platform provides a way to accomplish this, but it is always possible to create content that does not meet the standards.

The terms VPAT (Voluntary Product Accessibility Template) and ACR (Accessibility Conformance Report) commonly come up in conversations surrounding accessibility [29]. VPAT is the template that is used to generate an ACR. The ACR indicates compliance with Section 508 of the Rehabilitation Act of 1973 and W3C/WAI WCAG 2.0 and 2.1 compliance [29].

Each of the reviewed LMS platforms identify their compliance using VPAT. When reporting WCAG compliance there are three levels: A, AA, and AAA. Level A is the minimum requirement and has 25 specific criteria a site must meet. Level AA adds 13 more criteria to Level A. Likewise, Level AAA adds 23 more criteria to level AA [30]. Table VIII shows the compliance level of each platform with respect to WCAG and Section 508 [31]–[35].

Compliance with Web Content Accessibility Guidelines (WCAG) 2.0 or 2.1 will allow institutions to avoid litigation [36]. Section 508 of the Rehabilitation Act of 1973 was

TABLE VIII
ACCESSIBILITY COMPLIANCE MATRIX

Standard	Canvas	Blackboard	D2L	Moodle
WCAG 2.0/2.1	2.1 AA	2.1 AA	2.1 AAA	2.1 AAA
Section 508	Yes	Yes	Yes	Yes

revised to require all federal agencies and contractors to be WCAG 2.0 compliant by 2018 [27].

In summary each platform provides similar levels of accessibility compliance and all of them comply with Section 508 of the Rehabilitation Act of 1973.

VI. LMS DOCUMENTATION COMPARISONS

Canvas has a community website where it posts guides and allows the community to answer questions [37]. However, the real benefit was the popup context help and the ever present orange question mark at the bottom right. These link directly to help resources and guides that can walk users through the processes on the screen. Searching Google provides the user with good results matching the same pages as Canvas suggests.

Blackboard help is a little more formal and makes you feel the age of the product. The help is readily available through a question mark at the bottom right of each page, and the same kinds of guides as Canvas will walk you through each process [38].

By comparison to the previous two LMS platforms, D2L brightspaces help was abysmal. Contextual help is minimal at best and is not even found on some LMS pages, nor does it link to other documentation. The Help menu item at the top contains one item, “Connect with Us,” which takes you to a support request page. They do have good documentation at their site, and it was easy to find useful information on using the features [39].

In early versions of Moodle, help was ubiquitous. Little question marks next to everything would give you contextual help about the item. Today those question marks are still available in edit mode, but no longer clutter the user interface everywhere. And, although those little question marks often popup enough information to move you along in the process of using a feature, they do not provide links to the documentation. Moodle provides a complete website for its documentation, and like the others, it provides detailed guides and information [40].

In summary, Canvas and Blackboard are the clear winners here, with Moodle an uneasy third over D2L Brightspace.

VII. CONCLUSIONS AND FUTURE WORK

Clearly when it comes to popularity, Canvas is the hands down winner.

Features and ease of use evaluation clearly shows that each LMS has kept pace with the other platforms. The summary results of LMS activity types from Table VII show that Canvas, Blackboard and Moodle are merely a tenth of a point apart in features showing that feature comparisons of the top four are quite close. Thus we conclude that these systems have reached

a point of maturity which indicates that the systems have the most commonly required features. In addition, they have the ability to integrate with other tools and platforms to provide other needed features.

Documentation is good across the board, but is better integrated in Canvas and Blackboard. Moodle has some documentation integration, but not as good as Canvas and Blackboard. D2L had almost no integration in the test platform that we accessed.

Accessibility in each LMS platform meets the requirements to avoid litigation from the US government and clearly this has been a priority of the different systems based on their websites touting compliance. Interestingly, D2L and Moodle are the only ones boasting of AAA compliance. But we conclude that all of these are acceptable.

Ease of use, measured by time to implement a feature, was likewise close. However D2L and Moodle both suffer from too much clicking and scrolling. That leaves our analysis in agreement with the popularity order: Canvas, Blackboard, D2L and Moodle.

Future work might include in-depth ease of use evaluation of the most often used features by panels of faculty and students across different disciplines. Yearly popularity data also needs to be publicly available.

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