University of Minnesota
Learning Management System (LMS)
Review – 2017 Report

March 3, 2017

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2 EXECUTIVE SUMMARY

2.1 BACKGROUND

The University of Minnesota joined the Unizin consortium in September 2014 as part of a joint sponsorship between the Provost's office, Office of Information Technology (OIT), and the Libraries. Part of the UMN's obligation as a Unizin member is to pilot the learning platform Unizin has chosen, the Canvas Learning Management System (LMS).   The term of the pilot was initially planned for fall 2015 through May 2015, but was lengthened and became a formal evaluation through December 2016.

The ULTA (University Learning Technology Advisors) faculty advisory group convened in October 2016 to deliberate on a proposal that UMN continue as a member of Unizin and move to its chosen learning management system (LMS), Canvas.

2.2 PROPOSAL UNDER CONSIDERATION

The proposal submitted by Academic-Technology OIT leadership describes the work being done among UMN, Unizin peer institutions and Unizin, Ltd. staff as the most effective way to provide a technology framework that would support a teaching and learning ecosystem for UMN future students and faculty.   UMN's current onsite Moodle LMS has worked well for the University for several years, but changes in technology, among other factors, have led to a desire to replace an onsite system that is becoming unsustainable.

The Canvas LMS is Unizin's chosen learning platform; in fact, the University of Minnesota is the only member of Unizin that does not use Canvas. Canvas was chosen by Unizin because it fulfills .functional domains of a Next Generation Digital Environment, a framework that supports common standards and interoperability among connecting systems. These help reach mission-critical goals of Unizin member institutions who want to own their own intellectual property and data and create customized learning ecosystems to fit their current and future needs.

The proposal suggests a timeline for a transition to Canvas of 18 months-2 years, to be determined in consultation with academic units. OIT will also provide transition services and support to academic units, to be determined in consultation with academic units.

2.3 LEARNING MANAGEMENT SYSTEM (LMS) MARKET REVIEW

Data from MindWires LLC informs a series of reports published by e-Literate called *LMS Market Dynamics*. The reports provide information to describe the current positions of Moodle and Canvas in the LMS market and describe trends of higher-ed institution LMS adoption. These findings are noted:

- As cloud hosting and Software as a Service (SaaS) technologies matured, more higher ed institutions began moving their LMSs from onsite implementations to vendor hosted solutions. **In 2017, 85% of LMSs in higher ed are vendor-hosted or cloud based, and only 15% are hosted by institutions.**
- Canvas has been a force of change in the LMS market since its introduction in 2011. Their cloud-based hosting, attention to functionality, and reputation for ease of use and good

customer service have made them the fastest growing LMS in the market (77% of new LMS adoptions in U.S. higher ed last year were of Canvas). Other vendors have reacted by attempting to emulate what has made Canvas successful (*LMS Market Dynamics*, *Spring*, p. 15).

2.4 MOODLE LMS AND MOODLE AT UMN

Moodle is an open source LMS, supported by a partner network that funds an Australian corporation - Moodle Pty - that does most of the Moodle software development.

The Moodle LMS has been the centrally supported LMS for the University of Minnesota since 2009. Mirroring the experience of other institutions using WebCT, UMN's transition to Moodle was a "forced migration" necessitated when Blackboard discontinued its support of the WebCT LMS.

UMN's current Moodle system is one of the largest in the world. For the academic year 2015-2016, UMN has:

> Total Moodle Users = 106,433
> Total Number of Courses = 15,842
> Number of Academic Courses = 12,937
> Number of Non-Academic Courses = 2,905

Moodle use across UMN colleges:

- the UMTC College of Liberal Arts has by far the largest number of active Moodle courses--2,500-3,000;

- the UMTC College of Science and Engineering comes in second with slightly more than 1,000 courses;

- seven colleges have 500-1,000 active courses; and

- the remaining 31 colleges/schools have less than 500 active courses each.

2.5 CONCERNS ABOUT SUSTAINABILITY OF UMN'S ONSITE MOODLE SYSTEM

This report uses Peter Sandborn's definition of "sustainability" as described in his 2010 white paper, Sustainability/Sustainment Definition, produced verbatim below:

- the capacity of a system to endure;
- development, production, operation and management of systems that maximize the availability[1] of goods and services while minimizing their footprint;
- development, production and management of systems that provides the best outcome for all stakeholders now and for as long as required into the future.

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[1] "*availability*– this represents the fraction of time (or some other measure of life) that a good or service is in the right state, supported by the right resources, and in the right place when the customer requires it (the "customer" could be an individual, a company, a city, a geographic region, etc.)" (Peter Sandborn, Sustainability/Sustainment Definition).

Concerns about sustainability are in the areas of --

- Moodle's position in the LMS market: the data shows zero market growth in 2016. This affects the quality of integrations UMN can get from third party vendors as well as being a warning sign about the future health of the LMS.

- UMN's position as an "outlier" among higher-ed Moodle implementations in terms of size and complexity: UMN is one of the biggest, most complex Moodle implementations in the world and there are very few large institutions using Moodle. As a result, the special needs of large institutions are not considered a priority by Moodle developers. As a large institution, UMN experiences unique problems because of its size. When UMN's Moodle system experiences a problem, here are few peers with which UMN can share ideas and solutions.

- use of Moodle by few of UMN's peer institutions: UMN is the only member of the Big Ten Academic Alliance (formerly the CIC) to use Moodle. 64% of our BTAA peers use the Canvas LMS. Among our Carnegie R1[2] (Research 1) peers, seven institutions use Moodle, and one uses multiple systems, including Moodle--only 6% of our R1 peers.[3] Of the 115 Carnegie R1 institutions, 42, or 37%, use Canvas. These are sobering data points for a University that considers itself a world-class institution.

- technical challenges due to Moodle design issues: continuing to invest in an LMS that has difficulty accommodating the size and complexity of the University is becoming hard to justify, as well as increasingly expensive. An analysis by the Office of Information Technology (OIT)'s Architect and Systems Integration staff describes the UMN's Moodle installation as "running at a scale that Moodle's architecture is not intended to support." The ASI analysis concludes, " "We're at the edge of what we can do with hardware/software/Moodle design as it is. Increased demand will require a significant research effort to identify new solutions."

  ...and resulting expense: over the past 3 years and projecting into 2017, use of Moodle will have grown by 34%; the number of staff supporting Moodle will have more than doubled, from 10 to 22 FTE; and the cost for staff to support Moodle has nearly doubled. There is also an "opportunity cost": these resources are being used just to keep the LMS running, and would be better used directly supporting the teaching and learning mission of the University.

- consequences and risk incurred by UMN: learning has become a 24/7 online experience, and higher ed institutions struggle to provide a system that can meet the high expectations of modern learners. Vendor-hosted and cloud-based solutions come the closest, as comparisons

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[2] The Carnegie Classification of Institutions of Higher Education is the leading typology of American colleges and universities. It is the framework in which institutional diversity in U.S. higher education is commonly described (from http://carnegieclassifications.iu.edu).

[3] Brandeis University, California Institute of Technology, Louisiana State University and Agricultural & Mechanical College; North Carolina State University at Raleigh, University of California-Santa Barbara, University of Massachusetts-Amherst, University of California-Los Angeles (which uses multiple LMSs, including Canvas), University of Minnesota system.

of outage times (planned and unplanned) show, between our Moodle onsite system, and Canvas's and Moodlerooms vendor-hosted LMSs.

In addition, UMN's system administrators have devoted significant research and testing time to scan UMN's Moodle system for security. Additionally, University Information Security performed a high level security assessment of Canvas and Moodle Learning Management Systems. While details of that analysis are not provided here in order to prevent the introduction of additional risk, the analysis identified numerous security challenges with our existing Moodle environment.

2.6 USER ASSESSMENT

Feedback on Canvas was elicited from faculty and students by survey and focus groups for each semester. Canvas usability studies were also conducted with the faculty and students. Below are the results for the fall 2016 semester pilot. (A summary of past evaluation results may be found in the UMN Canvas Pilot 2015-16 Report.)

2.6.1 Fall 2016 Evaluation Results

2.6.1.1 Instructors

Instructors showed a preference for Canvas (59%) vs Moodle (12%) with the remaining 29% having no preference between the two. When asked whether the university should switch LMS, 79% of instructors were in favor of a transition to Canvas. Instructors were not compensated for participating in the pilot for fall 2016. Approximately half of the F2016 instructors were new to using Canvas.

2.6.1.2 Students

Students also showed a preference for Canvas (50%) vs. Moodle (27%) with the remaining 23% having no preference between the two. When asked whether the university should switch LMS, 60% of students were in favor of a transition to Canvas. Students had a very strong preference for a single LMS with 79% in favor, only 13% without preference and 8% preferring multiple LMS systems.

2.6.2 Usability Study Results

After participating in the usability study, participants were also asked to rate Canvas on a System Usability Scale (SUS)[4]. Instructors gave Canvas an average SUS of 61; students gave Canvas an average SUS of 76 (an average score is 68)[5].

2.7 TECHNICAL EVALUATION

The Canvas project team performed a full technical evaluation in the report of the previous pilot and an update for the fall 2016 semester. This report provides shorter summaries with fall 2016 updates.

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[4] The SYSTEM USABILITY SCALE (SUS) is the most widely used standard questionnaire for measuring the perception of usability. First developed in 1986, it has been used on software, websites, mobile phones, hardware, interactive voice response (IVR) systems and even paper ballots. It has been cited in over 600 research publications and is part of leading commercial usability-evaluation tools" (Usability Evaluation Summary Report, p. 7). While interpretation of the SUS depends on many factors, the average SUS score is 68.

[5] The scale is out of 100, but usability scores should not be interpreted as percentages. For more, see information about the System Usability Scale (Wikipedia).

- **Release schedule**: In contrast with the side-by-side upgrade process currently employed with the University's Moodle offering and the cadence release model of Blackboard's Moodlerooms, Instructure employs a continuous delivery, upgrade-in-place strategy. Long-term advantages include a common production environment and stable user identities within the system; however, it also introduces complexities and challenges in dealing with a 3-week change cycle with limited options to control.
- **Availability**: our onsite Moodle implementation uptime is 99.557%; Moodlerooms uptime is 99.996%; Canvas uptime is 99.965%. While they seem largely the same, once extrapolated over the time period of a year, for example, the differences are larger.
- **Tools and features**: Canvas met or exceeded virtually all of the requirements for the functional areas defined by the technical team. It offers the functionality and usability that is needed and expected from a LMS.
- **Integrations**: Canvas offers the necessary technology to allow integrations to University systems, University-developed tools, and third-party tools.
- **Course migration**: a converter is available to facilitate the import of Moodle content and activities into a Canvas course; it was successfully used during the pilot. It requires instructors or course designers to re-organize the content once in Canvas. To move large quiz question databanks, use of the Respondus Quiz tool is required.
- **Analytics and reporting**: Canvas offers a variety of analytics and reporting functionality: student-facing, instructor-facing, and administrator/researcher-facing.

2.8 MOODLEROOMS AND CANVAS ACCESSIBILITY

To minimize issues with accessibility, Canvas was developed using modern HTML and CSS technologies. Instructure is committed to W3C's Web Accessibility Initiative and Section 508 guidelines.

Blackboard, the company that owns MoodleRooms, designs and develops all products in accordance with Web Content Accessibility (WCAG) Guidelines 2.0 Level AA as well as the Section 508 standards in the U.S. A third party "conducts regular audits" of their software.

Both Instructure (Canvas) and Moodlerooms provides a VPAT (Voluntary Accessibility Template) as a tool decision-makers may use to evaluate Canvas' conformance with the accessibility standards under Section 508 of the Rehabilitation Act and the Act WCAG 2.0 AA Standards. [6]

2.9 NEXT GENERATION DIGITAL LEARNING ENVIRONMENT (NGDLE)

Participation in the consortial effort of Unizin, coupled with the current LMS review, has become a catalyst for developing a vision for the future of teaching and learning at the University of Minnesota, drawn in part from the influential framework for this future growth and flexibility is outlined in an article sponsored by EDUCAUSE and The Bill and Melinda Gates Foundation, called The Next Generation Digital Learning Environment (NGDLE).   The technology and architecture must address 5 domains of core functionality:
- Interoperability and Integration
- Personalization Analytics,

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[6] https://community.canvaslms.com/docs/DOC-2061

- Advising, and Learning Assessment
- Collaboration
- Accessibility and Universal Design

An NGDLE-based learning ecosystem would have an LMS as only one of interconnected tools that would use common standards to easily transfer data among the systems, allowing the lego-like plugging and unplugging of systems, as well as common data standards to allow easier transmission of data in and out of the system.

An NGDLE "scorecard" comparing Canvas/Unizin with Moodle gives Canvas/Unizin a "B/A" and Moodle a "C" in an A-F letter grade scale.

2.10 UMN AND THE UNIZIN CONSORTIUM

The decision to join Unizin was a strategic investment to help prepare UMN for the future of digital learning. As part owners of Unizin, UMN works with other leading research institution consortium members to direct the future of education, teaching technology, and learning analytics with the goals of improving access, affordability, and learner success.

The members of the Unizin consortium are:

Colorado State University
University of Michigan
University of Wisconsin-Madison
University of Minnesota
The Ohio State University
Florida State University System

Indiana University
University of Florida
Oregon State University
University of Iowa
The Pennsylvania State University

The goals that unite the member institutions under Unizin are to:

- Help direct the future of digital education, teaching technology, learning analytics and advising,
- Create the learning ecosystem of the 21st century,
- Keep control of our intellectual property and data, and
- Save money for institutions and, ultimately, students.

As a founding member of the Unizin consortium, UMN has representation on the Unizin board of directors, and so provides input to the priorities and projects of Unizin.   As a member institution of Unizin, the University of Minnesota directly influences Unizin's development of applications and services that will fit the University's needs, and leverages consortial knowledge and efforts in piloting and improving Unizin applications and services.

UMN is currently involved in seven pilots/initiatives with Unizin:

1. **Unizin OER (Open Education Resource) Authoring Task Force Report and Pressbooks** (open resource publishing platform), led by University Libraries.
2. ***Engage* digital content platform**, led by University Libraries. Now in its third semester of a

pilot.
3. ***Course Development Suite***, led by University Libraries. Just finished alpha development, beginning evaluation. (Development has just begun, and there is more potential than actual product here.)
4. ***Course Monit*or data dashboard, formerly known as *Snapshot*,** led by Academic Technology-OIT. Pilot now in its second semester.
5. **Unizin Data Warehouse**, led by OIT. In pilot production and receiving student performance data from the Canvas LMS. A proof-of-concept project in process, combining data from Canvas, PeopleSoft, and Aplus advising system to create a "common data layer" upon which to conduct analysis for decision-making and reporting.
6. **Unizin Learning Analytics Community of Practice**: UMN staff and faculty participate monthly. In March 2017, the Center for Educational Innovation begins a **UMN Learning Analytics Faculty Community of Practice**, co-hosted with UMN learning analytics researcher Prof. Bodong Chen (CEHD).

2.11 UMN's Future Learning Ecosystem

Based on trends in higher education technology and work done at UMN peer institutions, the tools and services the Unizin consortium is developing will be needed, and expected, by UMN faculty and staff within the next 1-5 years. These are in the Unizin-focused areas of digital content creation, management and sharing (including open educational resources) and learning data analytics.

A cost comparison shows that continuing our membership in Unizin provides these tools in the most cost-effective and efficient way, and would allow UMN more direct influence on the shaping of its digital future. By continuing down the path of partnership in the Unizin consortium, UMN's learning ecosystem will be able to grow, becoming the powerful platform our students and faculty need to move into the future.
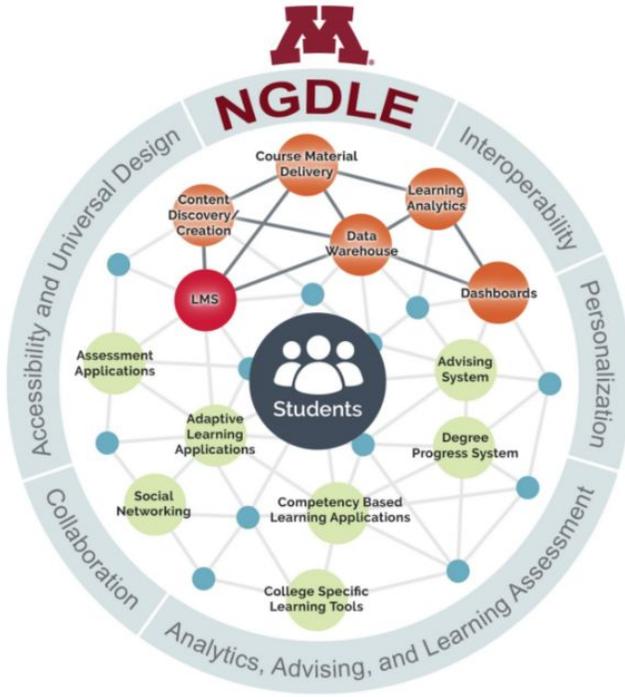
Unizin Products

- **Course Material Delivery** (Unizin Engage)
- **Content Discovery/Creation** (Unizin Course Development Suite)
- **Learning Analytics**
- **Data Warehouse** (Unizin Data Warehouse)
- **Dashboards** (Unizin Course Monitor aka Snapshot)
- **LMS** (Canvas by Instructure)

UMN Canvas Pilot – 2015-2017 Full Report

3 BACKGROUND

The University of Minnesota joined the Unizin consortium in September 2014 as part of a joint sponsorship between the Provost's office, Office of Information Technology (OIT), and the Libraries. Part of the UMN's obligation as a Unizin member is to pilot the learning platform Unizin has chosen, the Canvas Learning Management System (LMS).   The term of the pilot was initially planned for fall 2015 through May 2015, but was lengthened and became a formal evaluation.

3.1 UNIVERSITY LEARNING TECHNOLOGY ADVISORS (ULTA)

Created in response to a recommendation from the 2015-16 Academic Technology Formal Community of Practice (FCoP) at UMN, the ULTA group is composed of 28 faculty representatives from across the University and a limited group of central technology and learning representatives.

This group's main goal is to provide a faculty voice to formally evaluate and provide recommendations regarding new technology opportunities, while maintaining an awareness of their teaching and learning implications across each college and system campus. In addition, each technology is evaluated based the long-term development and integration requirements.

ULTA faculty were nominated by the deans of their respective colleges and chancellors (or their delegates) at system campuses. More information about ULTA, including its charter, may be found at the ULTA web site at http://ulta.umn.edu.

ULTA first convened on October 28, 2016 under Chair Lee-Ann Breuch, Associate Professor in the Department of Writing Studies, College of Liberal Arts to deliberate on the first proposal brought to them for consideration from Academic Technology leadership in the Office of Information Technology (OIT). The text of the proposal follows.

3.2 PROPOSAL TO ULTA FROM ACADEMIC TECHNOLOGY-OIT

University of Minnesota Academic Technology - Office of Information Technology (AT-OIT) is proposing that the University renew its membership in the Unizin consortium (due for renewal in May 2017) and move to the consortium's chosen platform, Instructure's Canvas, as the centrally-supported learning management system (LMS).

The question for ULTA:

Should the University of Minnesota continue its membership in Unizin and adopt its platform, Canvas, as our centrally supported learning management system?

3.2.1 Proposal Introduction

"Our University will be more nimble, innovative, and integrative, and thereby better serve our students and state. We will advance our mission, enlarge our shared aspirations, and meet the challenges of a diverse and changing world."

—SVPAA/Provost Karen Hanson (Driving Tomorrow, UMN's 10 year strategic plan)

In 2014, the Provost's office, the Office of Information Technology, and University Libraries sponsored the University of Minnesota's membership in the Unizin consortium. The decision to join was a strategic investment to help prepare the University for the future of digital learning. As part owners of Unizin, the University works with other leading research institution consortium members to direct the future of education, teaching technology, and learning analytics with the goals of improving access, affordability, and learner success.

Part of the University's obligation as a Unizin member is to pilot Canvas. As the first year of the pilot ended in 2016, AT-OIT saw promising data and feedback from faculty, students, and academic technologists that point to Canvas having the functionality and features required for the University's current needs as well as the ability to support future growth. The provost and interim VP-CIO agreed to move to a formal evaluation period to compare Moodle and Canvas in order to select the best option for the University's future.

In the past several months, the University's work with Unizin has begun to bear fruit. In the areas of digital content, extensible learning platform, and learning analytics, OIT-AT believes Unizin provides the tools and services University faculty and staff will need and expect within the next 2-5 years, in the most cost-effective and efficient way.

As a member institution of Unizin, the University of Minnesota can help direct Unizin's development of applications and services that will fit the University's needs and leverage consortial knowledge and efforts in piloting and improving Unizin applications and services.

Currently, the University is piloting not only Canvas, but Unizin's Snapshot[7] dashboard tool and Unizin's Engage digital content platform (in partnership with UMN Libraries). UMN Libraries plans to pilot Unizin's Content Studio suite of tools in spring 2017.

3.2.2 Proposal: Current Situation

The current LMS environment, Moodle, has served the University's needs for several years; however, Moodle is not well-positioned to provide the strong and flexible learning environment the University will need in the future. Specifically, the current onsite Moodle implementation is not sustainable. Recurring unplanned outages and service slowness have become more common due to design limitations of Moodle to scale to meet user volume and the growing complexity of maintaining the infrastructure that supports it. Ever-increasing resources have been needed to keep the core system running and this has prompted OIT's decision to move to a Software as a Service (SaaS) LMS provider that offers cloud based hosting.

An LMS is a critical system for teaching and learning. Since a SaaS LMS will provide stability, speed,

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[7] Recently renamed *Course Monitor.*

cost predictability, and 99.9% availability, whether the University chooses Moodle or Canvas, OIT plans to transition its LMS to the cloud.

Unizin Consortium

Unizin will provide digital tools and services for teaching and learning that University faculty and staff will ask for and expect in the near future (1-5 years). These are in the areas of: digital content discovery, curation and sharing; digital platforms; and learning analytics.

The other options for providing these tools and services are to purchase them from vendors, or to develop them in-house. UMN should continue to build on its investment in Unizin because it enables the University to develop and deploy Unizin's teaching and learning tools to maintain control of its own customized digital ecosystem and provides a flexible and responsive teaching and learning infrastructure for future growth.

Unizin tools, combined with the Canvas platform, provide the most cost-efficient and effective way for the University to provide faculty and students with a digital ecosystem that creates a "next generation digital learning environment" (NGDLE), the "functional domains" of which are:|

- *interoperability;*
- *personalization;*
- *analytics, advising, and learning assessment;*
- *collaboration;*
- *and accessibility and universal design.*

3.2.3   Proposal: Canvas

Canvas was chosen by Unizin (through an RFP) as its platform because it provides a teaching and learning infrastructure and development framework that aims to support the functional domains of an NGDLE-type system.

The Unizin board of directors has determined that Unizin applications and integrations will be developed and supported only for the Canvas LMS in order to focus on applications that further the goals of Unizin's planned ecosystem. Only one other Unizin consortium member - the U of Florida system - does not use Canvas as its LMS.[8] At this time, Unizin does not plan to develop integrations with other LMS platforms.

It is possible, as far as we know, for the University to continue to be in the Unizin consortium while having Moodle (in the cloud) as its centrally-supported LMS. However, it would require that the University develop its own integrations from Moodle to Unizin applications.

If the University were to continue to use Moodle, our institution would not realize critical advantages of belonging to the Unizin consortium, and it would impede progress toward meeting strategic institutional goals:

- *use of a different LMS will complicate collaborations with other institutions in Unizin who are*

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[8] Since this was written, the University of Florida system has selected Canvas as its centrally-supported LMS, leaving the University of Minnesota as the sole Unizin member using a different LMS.

all using the same LMS (Canvas). Using the same LMS would allow easier collaboration and speedier advances in developing and deploying Unizin applications and services, which would enable us to more quickly meet the University's teaching and learning needs;

- *The University of Minnesota would need to devote in-house staff resources to creating integrations between Moodle and Unizin applications. If Canvas is chosen, integrations are delivered through Unizin, and University resources could be deployed more strategically in collaborating with Unizin partners and developing/customizing the platform in ways that support University teaching and learning needs.*

Continuing to follow the path that we are on with Unizin and adopting its platform supports the University's strategic goals, and in SVPAA/Provost Karen Hanson's words, will "...support excellence and, with intention, reject complacency" ([Driving Tomorrow](#), UMN's 10 year strategic plan).

3.2.4   Proposal: Data gathered to Test the Proposal

To help make the most informed and best decision for the University will be a thorough process that involves consultations, testing, and in-depth reports including cost comparisons, analysis of tools and features, and migration assessments.

3.2.5   Proposal: Timeline for Decision
The proposed timeline for ULTA's process is:

1. *October 28, 2016: ULTA convenes*
2. *December 16, 2016: LMS review period ends*
3. *February 28, 2017: pilot report completed*
4. *March 3, 2017: ULTA report available to public online for comment*
5. *March 31, 2017: ULTA makes recommendation*
6. *Spring 2017: LMS direction determined*

3.2.6   Proposal: Timeline for LMS Transition
Any timeline for an LMS transition is tentative until colleges and OIT's transition team can confer. The on-site Moodle system and Canvas would run as parallel systems, with delivery of live courses phasing out as the transition completes. Student survey data from the pilot makes clear that they prefer not to have to wrestle with more than one LMS for their courses, so UMN should aim for the shortest transition time it can realistically support.

Based on the experiences of other institutions, a tentative timeframe of 18 months to two years is realistic. After that point, content from old courses on Moodle servers will remain archived (and retrievable) as UMN's [Moodle 5-year lifecycle process](#) plays out.

3.2.7   Proposal: Course Transition Resources
OIT would offer support to faculty and college IT during the transition. Work done by staff supporting the Canvas pilot and testing effort of course conversion for the ULTA report will help inform a transition plan. After the LMS decision is made, an LMS transition team would be created to work with colleges to create a continuum of strong support that fits their needs. It is anticipated that this may include online resources, drop-in sessions, online and face-to-face workshops, and temporary staff

assistance.

This report attempts to pull together the data and resources outlined in the proposal and requested by the members of ULTA in order to assist ULTA in making a well-informed, data-driven recommendation.

3.3 DATA REQUESTS FROM ULTA

3.3.1 Canvas Pilot Courses

At the request of ULTA members, LMS usage at UMN has been analyzed. Following are the requests and supplied data.

- *How many online-only courses participated in the Canvas pilot?*[9]

	Number of Online-Only Courses	Number of Online-Only Courses (moved from Moodle)
Spring 2016	20	18
Fall 2016	10	4

- *How many ULTA committee members have used Canvas?*

Nine of the 28 members of ULTA have taught courses in the Canvas pilot. Below is a listing of these faculty and their courses sorted by college:

1. UMC Undergraduate Studies
   o Brorson (MGMT3200 [Fall 2015])
2. UMM Undergraduate Studies
   o Lamberty (CSCI1201 [Spring 2016], CSCI3601 [Spring 2016], CSCI1801 [Fall 2016], CSCI4656 [Fall 2016], CSCI4901 [Fall 2016], Dig Med Comp [Spring 2017], Software Dsn [Spring 2017])
3. UMTC College of Biological Sciences
   o Moe (BIOL1001 [Spring 2016], BIOL1001 [Fall 2016])
4. UMTC College of Continuing Education
   o Bonnac (ESL3007 [Fall 2016], ESL310 [Fall 2016])
5. UMTC College of Design
   o Sandler (ARCH4410 [Fall 2016], ARCH5412 [Fall 2016])
6. UMTC College of Education & Human Development
   o Trites (PSTL1461 [Spring 2016], FSOS 1461 [Fall 2016], FSOS 1461 [Fall 2016])
7. UMTC College of Science & Engineering

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[9] Data for this question is only available for Spring and Fall 2016 pilot cohorts. Some faculty did not respond to this question, so numbers are approximate.

o Driessen (CHEM1075 [Fall 2016])
8. UMTC School of Public Health
o Wolfson (PUBH7430 [Fall 2015], PUBH7430 [Fall 2016])
9. Center for Educational Innovation
o Alexander (GRAD8200 [Fall 2015])

- *What was the distribution of schools participating in the Canvas pilot? Were all schools represented?*

The following table lists the number of courses from each school during the pilot for each term of the pilot:

	Fall 2015	Spring 2016	Summer 2016	Fall 2016
UMC Undergraduate Studies	1	5		3
UMD College of Education & Human Service Professions		3		
UMD College of Liberal Arts		3	1	20
UMD Swenson College of Science & Engineering				1
UMD Labovitz School of Business & Economics		1	1	
UMD School of Fine Arts		2		1
UMM Miscellaneous		1		
UMM Undergraduate Studies		7		5
UMR Undergraduate Studies				2
UMTC Academic Health Center	1	3	2	2
UMTC College of Biological Sciences	1	2		1
UMTC College of Continuing Education		1		9
UMTC College of Design	4	2		9
UMTC College of Education & Human Development	11	37	4	18
UMTC College of Liberal Arts	3	7		11
UMTC College of Science & Engineering				4

UMTC College of Veterinary Medicine				2
UMTC Graduate School	1	1		
UMTC School of Public Health	2	4		6

- *Did Canvas pilot instructors develop new online courses or move courses from Moodle to Canvas?*[10]

	New Course	Move From Moodle
Spring 2016	11	57
Fall 2016	24	43

4   LEARNING MANAGEMENT SYSTEM (LMS) MARKET REVIEW

For the purposes of UMN's LMS evaluation, UMN has subscribed to e-Literate's *LMS Market Dynamics* reports, provided by MindWires LLC.[11]   The subscription provides reading access to published reports for all staff, faculty and students who are affiliated with a campus in the University of Minnesota system: Twin Cities, Crookston, Duluth, Morris, and Rochester.

The information that follows is summarized from their Fall 2016 and Spring 2017 editions.

4.1   LMS HISTORY TO MARKET TRENDS

4.1.1   Blackboard Catalyst for Forced LMS Migrations
E-Literate describes the LMS market from 2003-2011 as being driven by the biggest player in the market, Blackboard, its corporate acquisitions and institutions' reactions to these (Fall, p. 4). During that time, most institutions moved to a new LMS only when they were forced to – when an LMS was discontinued or acquired by another company (usually Blackboard).

4.1.2   Higher Ed LMS Market Moving to SaaS and Cloud solutions
Since 2011, this trend has begun to change, due to more adoption of technical interoperability standards[12] that make migration easier.

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[10] Data for this question is only available for Spring and Fall 2016 pilot cohorts. Some faculty did not respond to this question, so numbers are approximate.

[11] E-Literate's analyses are drawn from their exclusive access to the LMS market data of LISTedTECH, which has "the most complete and valuable educational technology data set available…Most of the data is updated regularly by LISTedTECH's team and is validated at the source." It includes data on 4,427 institutions in the US and Canada. For more information on data gathering methods, see Fall 2016 report, p. 20.

[12] *Interoperability* describes one of the functional domains of a Next Generation Digital Learning Environment: "IMS Global has many standards … including Common Cartridge, LTI, EDUPUB, Access for All, QTI (Question and Test

Coupled with this was "availability of vendor hosting in general and cloud-based offerings in particular" as more institutions began to realize that its "benefits in system reliability and total cost of ownership can be substantial" (Spring, p. 4).[13]

> *One of the clearest trends of the last several years has been a move away from self-hosting by institutions toward either vendor-hosting or a cloud-based solution. Fig. 1 below presents the clearest evidence we've seen for this trend. The inflection point came in 2012 when vendor hosted and cloud based platforms first represented more than 50% of new implementations. Just five years earlier, in 2007, 90% of LMS platforms were self-hosted by institutions.* **Now 85% are vendor-hosted or cloud based and only 15% are self-hosted by institutions.** *The introduction and growth of Amazon Web Services (AWS) facilitated this trend, and was leveraged very effectively early on by Canvas.* (Fall, pp. 12-13).

The graph below illustrates the trend. In 2016, 85% of LMS migrations were to hosted solutions, while only 15% of institutions chose an on-site LMS implementation.

Interoperability), Learning Information Services, and Caliper Analytics" ([The Next Generation Digital Learning Environment: A Report on Research](#), p. 14).

[13] Clarification of terms:

	Where infrastructure is housed	Who manages infrastructure
In-House	Onsite (e.g., at UMN)	UMN
Cloud	Vendor	UMN or Vendor
Software as a Service (SaaS)	Vendor	Vendor
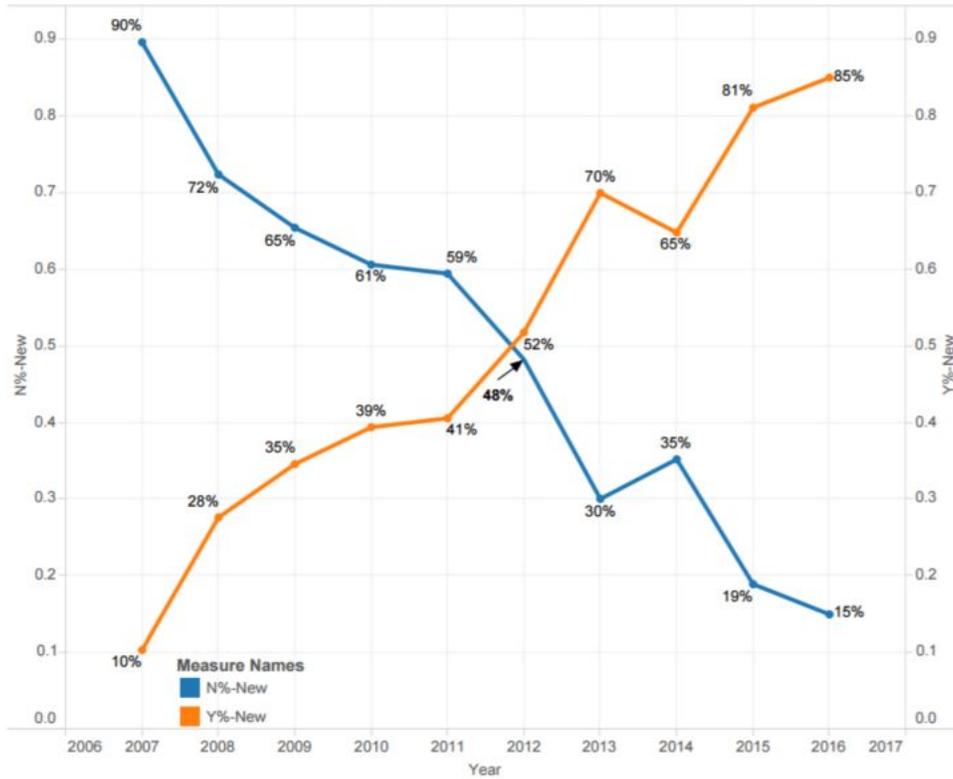
Figure 1 Percentage of New Implementations that are Hosted (Spring, p. 13)

Instucture's Canvas LMS -- designed from its foundation as an SaaS application to take advantage of the benefits of the cloud -- has driven much of this trend.

4.2 INSTRUCTURE'S CANVAS MARKET GROWTH

Canvas's emergence into the LMS market in 2010 was a key event in changing the choices available to higher ed institutions.

> *The two attributes which got the most attention in early releases were (1) cloud-based hosting and (2) key functionality such as the Speed Grader and integrated Calendar that made important faculty tasks much easier to perform. In addition, they had (and still have) a reputation for ease of use and good customer service* (Spring, p. 14).

Bringing it up to the present, there are two notable data points related to Canvas: one, over the past year, Canvas has been selected by 69% of those institutions that are reviewing their LMS options, and two, it has kept its early adopter customers (Fall, p. 4).

The movement of higher ed institutions from one LMS system to another, between 2014-2016, is illustrated in the following graphic.

This chart illustrates the movement of customers from one LMS to another in a saturated market.
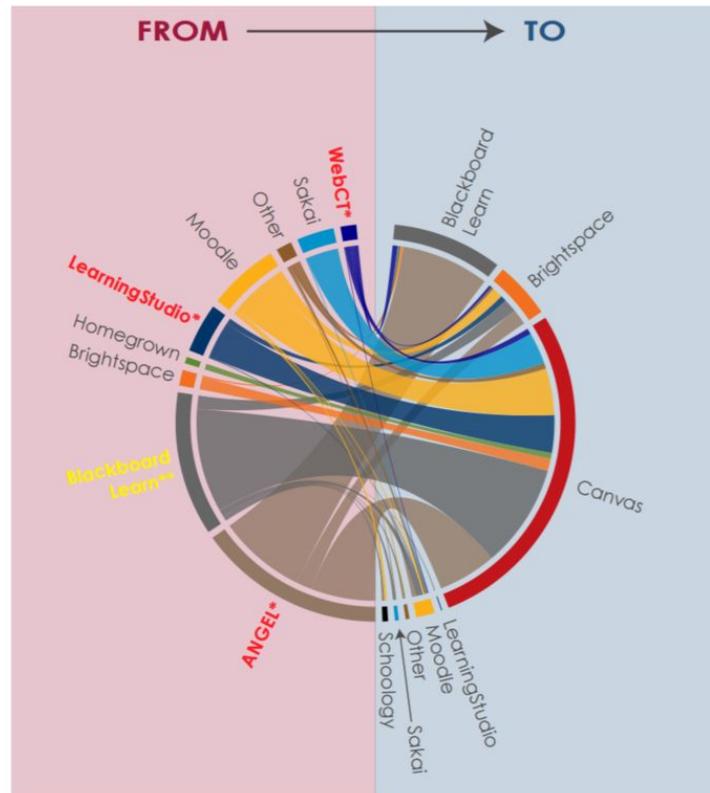
Figure 2 LMS Customer Migrations, 2014-2016 (Fall, p. 11)

According to e-Literate,

> *The net result [of migrations from one LMS to Canvas since 2011] is that a strong majority of new LMS implementations in US and Canadian higher education are currently coming from Canvas adoptions. While Canvas does not (yet) have the largest market share, its growth since 2011 has changed the nature of the academic LMS market. Importantly, rather than competitors primarily reacting to Blackboard and its strategic moves, the market is now reacting more to the attributes that have made Canvas successful:*
>
> *• Cloud hosting*
> *• Easy to use interface*
> *• Strong customer support*
> *• Improved grading and calendaring* (Spring, p. 15).

4.3 OPEN SOURCE IN THE LMS MARKET

Open source software appeals to many who wish to have the freedom to "own" and customize the applications they use, unimpeded by the control and potential cost hikes that come with commercial, proprietary software developed and maintained by vendors. See the table below for descriptions of

the terms and LMS examples of the different types of software.

	Free (as in Freedom)	Vendor controlled	Examples
	You may use, copy, and/or distribute, either verbatim or with modifications, either gratis or for a fee	Does a single/group of vendor(s) direct the development of the software?	
Closed Source/ Proprietary	No	Yes	Blackboard
Open Source	Some	Yes	Canvas
Free/Libre and Open Source	Yes	No (community controlled)	Moodle

Although the code for their LMS is available for anyone to take and run on their own, the Canvas LMS is owned and its development directed by the vendor, Instructure. There are many open source academic LMSs worldwide, but only two—Moodle and Sakai—are substantial players in the US/Canadian market. Both came of age as Blackboard was discontinuing its lower-end LMS offering, WebCT, and was acquiring other LMS vendors in the market. Moodle and Sakai found niches in the market that were not yet filled by commercial vendors (Spring, p. 10).

The use of the open source LMSs Sakai and Moodle plateaued in 2012. Their use has been declining slowly since then (see Fig. 3 below).
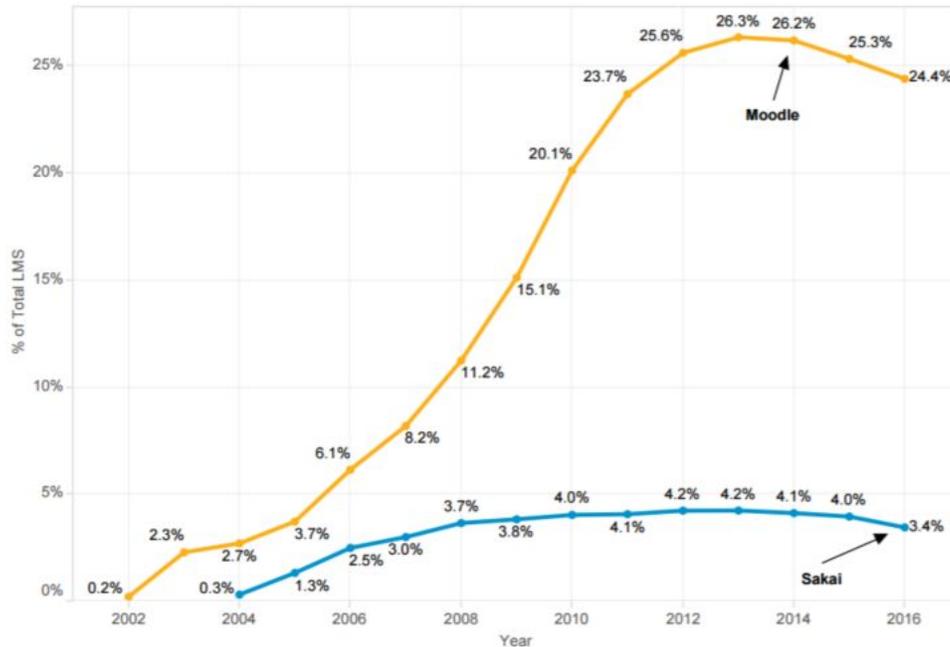
Figure 3 Open Source Plateau, Spring p. 12

4.4 THE MOODLE LMS

Moodle was originally developed by Martin Dougiamas, a graduate student in education and a WebCT administrator in Australia. It began to gain traction in the US and Canadian markets, according to E-Literate, for two primary reasons: it is "lightweight and easy to run" for small institutions[14], often starting as a 'rogue' installation running on individual faculty members' desktop computer, and it has a "robust support partner network," that funds an Australian corporation – Moodle Pty – which does most of the Moodle software development.[15]

4.5 MOODLE AT UMN

The Moodle LMS has been the centrally supported LMS for the University of Minnesota since 2009. Mirroring the experience of other institutions using WebCT, UMN's transition to Moodle was a "forced migration" necessitated when Blackboard discontinued its support of the WebCT LMS.

4.5.1 Current LMS (Moodle) Usage at UMN

For the academic year 2015-2016, UMN has -

        Total Moodle Users = 106,433
        Total Number of Courses = 15,842
        Number of Academic Courses = 12,937

---

[14] This is in contrast to Sakai, which was designed and developed to support large institutions as an enterprise-level LMS (Spring, p. 11).
[15] "Support partners pay Moodle Pty a percentage of their gross Moodle-related revenues in return for use of the Moodle trademark. (Those payments are used by Moodle Pty to fund ongoing development of the platform.)" (Spring, p. 11).

Number of Non-Academic Courses = 2,905

To answer the question of what Moodle use is across colleges, see Fig. 4 below for active number of courses in each college. Note that:

- the UMTC College of Liberal Arts has by far the largest number of active Moodle courses--2,500-3,000;

- the UMTC College of Science and Engineering comes in second with slightly more than 1,000 courses;

- seven colleges have 500-1,000 active courses; and

- the remaining 31 colleges/schools have less than 500 active courses each.

Moodle Courses by College
AY 2015-2016 (Moodle 2.8), all

College	Courses
CEHD Family & Social Sciences	
CEHD Organizational Leadership, Policy, & Development	
CEHD Postsecondary Teaching & Learning	
CEHD School of Kinesiology	
CLA Psychology	
UM Extension Non-Credit	
UMC Miscellaneous	
UMC Undergraduate Studies	
UMD College of Education & Human Service Professions	
UMD College of Liberal Arts	
UMD College of Pharmacy	
UMD Continuing Education	
UMD Labovitz School of Business & Economics	
UMD Medical School	
UMD Miscellaneous	
UMD School of Fine Arts	
UMD Swenson College of Science & Engineering	
UMM Miscellaneous	
UMM Undergraduate Studies	
UMR Miscellaneous	
UMR Undergraduate Studies	
UMTC Academic Health Center	
UMTC Carlson School of Management	
UMTC Center for Allied Health	
UMTC College of Biological Sciences	
UMTC College of Continuing Education	
UMTC College of Design	
UMTC College of Education & Human Development	
UMTC College of Food, Agriculture, & Natural Resources	
UMTC College of Liberal Arts	
UMTC College of Pharmacy	
UMTC College of Science & Engineering	
UMTC College of Veterinary Medicine	
UMTC Graduate School	
UMTC Hubert H. Humphrey School of Public Affairs	
UMTC Law School	
UMTC Medical School	
UMTC Miscellaneous	
UMTC School of Dentistry	
UMTC School of Nursing	
UMTC School of Public Health	

Figure 4 Moodle Courses by College

How does Moodle tool usage vary by college? Below are three different ways to answer this question.

- Figure 5 represents tool usage based on the number/percentage of courses using a particular tool. This gives a measure of which tools affect the most course sites. This is a general metric for tool importance across the University.

- Figure 6 represents tool usage based on the number of times used. This gives a measure of tool popularity among site creators. Tools that rank highly here, but not in the above, are tools that have a strong niche impact - heavy use in a smaller number of course sites.

- Figure 7 represents tool usage based on weighting by the number of students affected

(student enrollment multiplied by number of times the tool is used in the course). This gives a measure of tool importance based on students affected. Tools that rank highly here, but not in the two categories above, are tools that have a strong niche impact for large courses - use in a smaller number of large-enrollment courses.
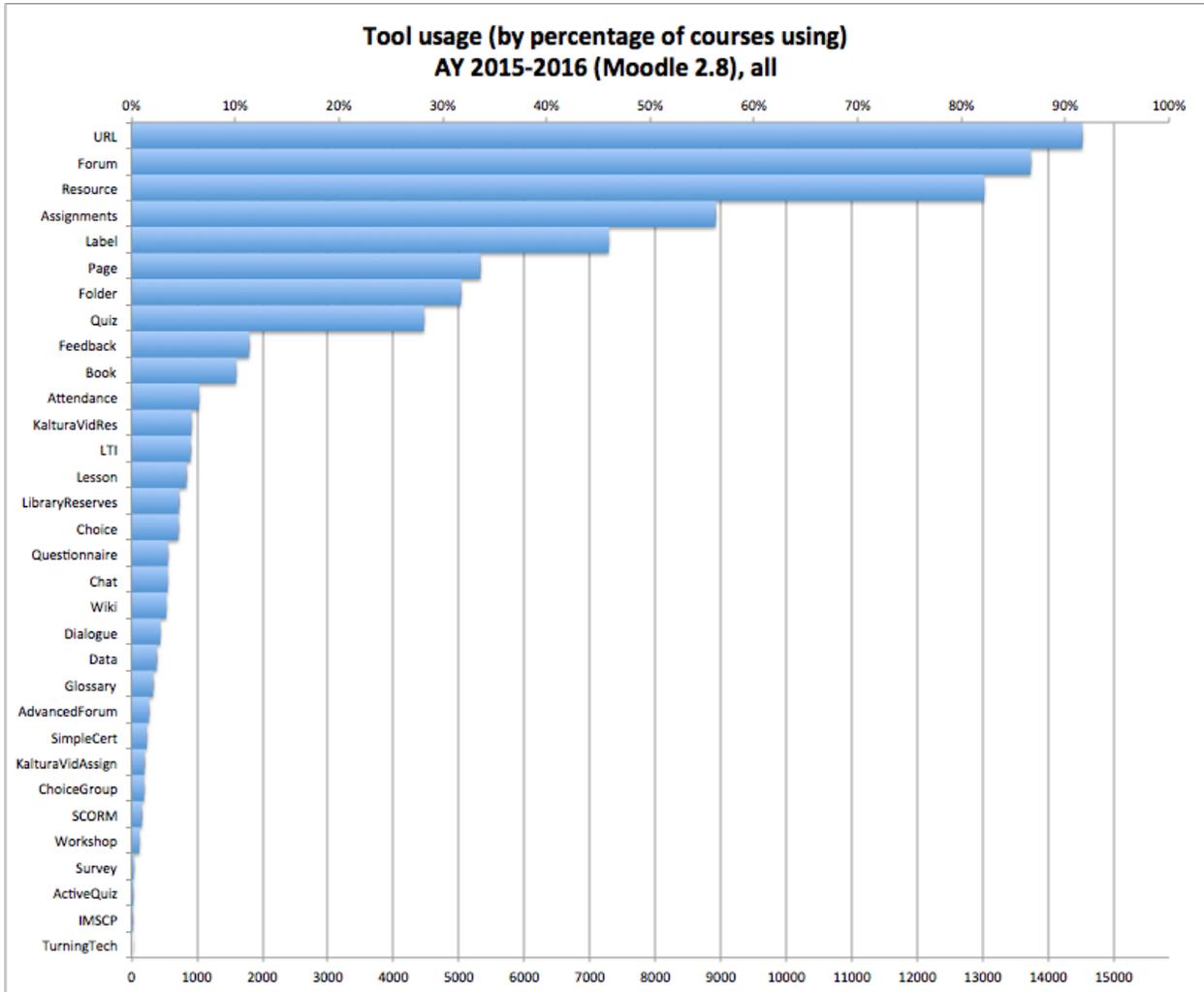
Figure 5 Tool Usage by Percentage of courses using a particular tool
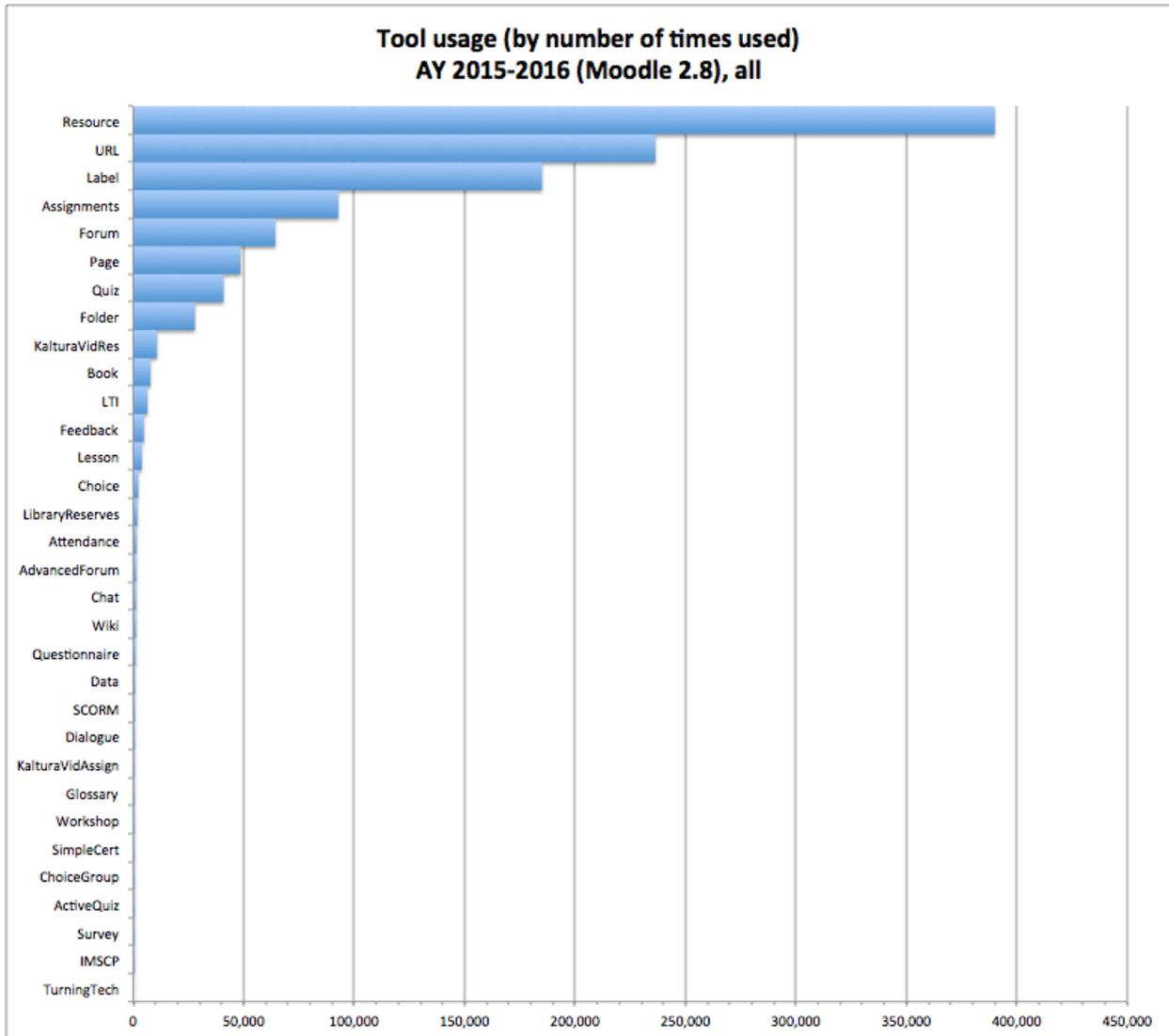
Figure 6 Tool usage based on the number of times used

Tool usage (weighted by students affected) AY 2015-2016 (Moodle 2.8), all
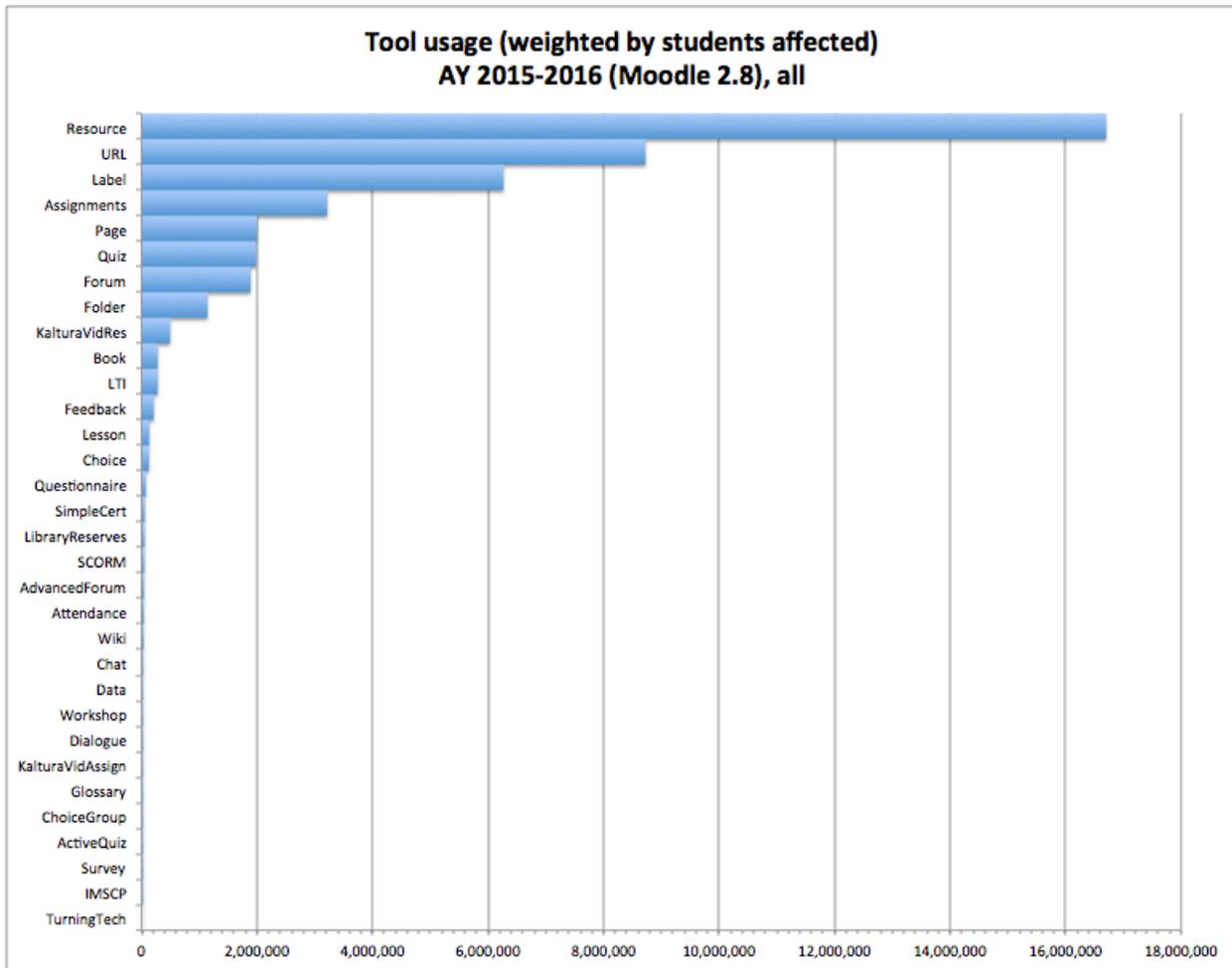
Figure 7 tool usage based on weighting by the number of students affected (student enrollment multiplied by number of times the tool is used in the course)

5 CONCERNS ABOUT SUSTAINABILITY OF UMN'S MOODLE SYSTEM

OIT leadership has become increasingly concerned about the sustainability of UMN's on-site, locally managed Moodle system.   To explore this, this report will use Peter Sandborn's definition of "sustainability" as described in his 2010 white paper, Sustainability/Sustainment Definition, produced verbatim below:

- the capacity of a system to endure;
- development, production, operation and management of systems that maximize the availability[16] of goods and services while minimizing their footprint;
- development, production and management of systems that provides the best outcome for all

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[16] "*availability*– this represents the fraction of time (or some other measure of life) that a good or service is in the right state, supported by the right resources, and in the right place when the customer requires it (the "customer" could be an individual, a company, a city, a geographic region, etc.)" (Peter Sandborn, Sustainability/Sustainment Definition).

stakeholders now and for as long as required into the future.

This definition of sustainability provides the framework for the discussion below.

Concerns about sustainability are in the areas of

- Moodle's position in the LMS market,
- UMN's position as an "outlier" among higher-ed Moodle implementations in terms of size and complexity,
- use of Moodle by few of UMN's peer institutions,
- technical challenges due to Moodle design issues and resulting expense, and
- consequences and risk incurred by UMN.

5.1 MOODLE'S ZERO MARKET[17] GROWTH

5.1.1 No growth in U.S./Canadian Moodle Customer Base

As the data used in E-Literate's fall report indicates (see Fig. 3 above), 2012 marked the high plateau of institutional usage of open source software and Moodle. Moodle's market share has been slowly declining since, from a high of 26.2% of all LMS implementations, to a current level of 24.4% (E-Literate spring, p. 12).

More concerning is the stagnation of Moodle's growth in the U.S./Canadian LMS market, which can be seen in the graph below. **The graph shows 0% growth in the past year – no new Moodle customers in the U.S./Canadian LMS market.** The graph's data also show that of all new LMS implementations in the past year, Canvas was chosen by 77% of U.S./Canadian institutions making a move.[18]
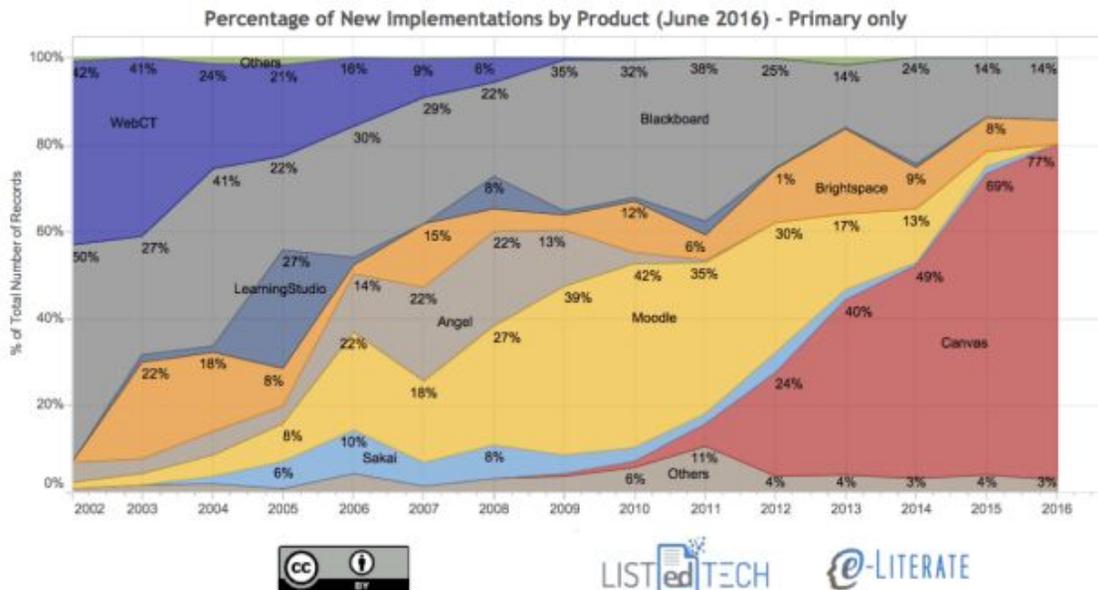

Figure 8

Zero growth in its customer base would be a grave concern for a vendor that sells its LMS, but why is it a concern for an open source LMS like Moodle? Moodle HQ founder and CEO Martin Dougiamas responded to a question about Canvas's competition at the 2016 MoodleMoot, saying that "Moodle is not profit-driven and it doesn't matter that much when schools move to Canvas."[19]

However, as blogger Phil Hill points out, U.S. higher ed institutions and Moodle partners certainly should care:

> *Moodle Partners care about their business, Moodle advocates care about the adoption and health of the open source community, and the level of Moodle development staff depends on how many schools choose Moodle over Canvas or any other solution (*MoodleMoot US 16*).*

Vendors that provide third-party integrations into LMSs also pay attention to how many students each LMS serves. UMN's Moodle instance has integrations with Turnitin's plagiarism checker, the i>clicker audience response system, and many others.[20] These integrations allow students such conveniences as single sign-on and grades passing between the third party software and the LMS.

These third-party vendors generally license (and so are paid) on a per-seat basis, so what matters to them is how many students would use the integrations they create: the more enrolled students use the LMS in question, the more impact (and higher return on investment) the vendor's integration will have for their company.

Data from *Edutechnica's*[21] fall 2016 "4th Annual LMS Data Update" indicates that Instructure's Canvas LMS has the second largest number of student enrollments of any LMS in the U.S, second only to Blackboard Learn (see the graph below).

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[19] MoodleMoot US 16: Playing Small-Ball, blog post by Phil Hill. August 3, 2016.

[20] Currently, UMN's Moodle implementation has 18 integrations with 3rd party applications.
[21] Focuses on US higher education institutions with more than 500 students.

Figure 9

http://edutechnica.com/2016/10/03/4th-annual-lms-data-update/
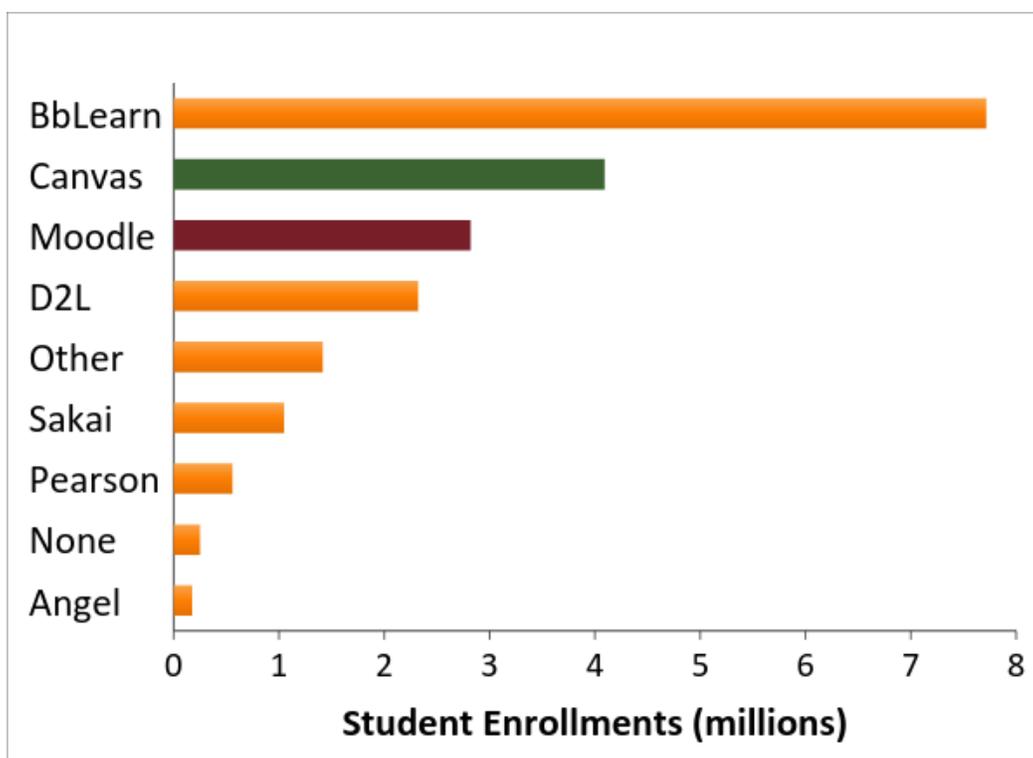
Experiences over the past two years have confirmed that some third-party vendors are more responsive to Canvas integration needs than they are to Moodle integration needs. UMN Moodle administrators have been frustrated at times with the unresponsiveness of third-party integration vendors to support issues that have arisen between their products and Moodle.[22]

As a related issue, LMS vendor "ownership" of integration issues, if done well, provides strong leverage in getting third-party vendors to fix what doesn't work. At Instructure, support managers gather incident data about third party vendor performance and use that data as leverage to get the integration providers to operate better.[23]

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[22] Experiences in the past two years that exemplify this issue: 1) at Qualtrics day at UMN in fall 2015, the community asked why there was no integration between Qualtrics and Moodle, when there was one for Canvas. Our service and business owners reached out to Qualtrics to pursue. Qualtrics was unresponsive to repeated attempts to discuss the issue; 2) in summer 2016, Moodle's service owner, Jeff Weber, talked to Turnitin's product manager about why they deliver their new version code late and why their Moodle plugin doesn't work well. He responded that they would get to the Moodle updates but they are prioritizing Instructure's Canvas integration higher.

The product manager added that Instructure gave them very specific instructions as to how to improve the vendor's integration with Canvas. In some cases, Instructure has actually offered to help with the development or review/test solutions to make their integration stronger.

[23] "The Latest from Customer Success and Support," presentation at InstructureCon 2016, July 20, 2016.

5.1.2 UMN's Size and Complexity

Another concerning factor is that UMN's Moodle implementation is an outlier in terms of size and system complexity. There are only a small number of higher ed institutions close to the size of UMN using the Moodle LMS – notably, Australia's Monash University and the Open University in the U.K.

The Open University in the U.K. is the poster child that proves Moodle can work for large institutions. But it has come with a very large price tag:

- Open University spent £5 million (6.2 million US dollars) to build their initial implementation in 2006/2007, starting out lean with 6-12 developers and a couple of testers; as of 2016, however, they have 20 developers, plus a number of business analysts, architects and support staff.
- They also utilize additional consulting resources (from two organizations: Catalyst & Luns) to help them with their development.
- In 2012 - they had 2,000 customizations to Moodle core; as of 2016, they have only about 20 customizations to Moodle core.
- 2005-2010, they compared running Moodle to whack a mole...when one issue was resolved another popped up. That was when they were running 4 webservers; today they run 12 webservers.

In 2016, the Open University seems to have found itself in a similar situation as UMN and other higher ed institutions: they announced that they are looking at cloud hosting. Jenny Gray, Open University's Head of Center of Excellence, said that "the world is changing so rapidly that we will be evaluating Moodle **every two years** to see if it is still the right choice for us as a university."[24]

The Open University has approximately 170,000 active users. UMN's size (and complexity) is in the same ballpark: it has one of the biggest Moodle installations in the world.

- o 126,000 to 175,000 active users
- o 8,000 to 10,000 concurrent users
- o 15,000 active courses
- o 90,000 total courses

It is all the more impressive – and a testimony to the resourcefulness and hard work of the staff -- that UMN's OIT AT Tools and infrastructure teams have been able to support UMN's Moodle needs so well, with its much leaner resources. (More on resources and increasing costs will be discussed in section 5.2).

UMN is an outlier in the size of its Moodle implementation. In the figure below, we see that the vast majority (around 800) of U.S. higher ed institutions that use Moodle have fewer than 3,000 students enrolled. One-quarter of Moodle-using institutions have between 3,000-12,999 students enrolled. "Large" implementations – over 14,000 enrollments -- comprise only a handful. See Fig. 10 below.

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[24] Source: Presentation and video by Jenny Gray, Open University's Head of Center of Excellence, http://www.moodlenews.com/2016/evolving-with-moodle-a-10-year-case-study-of-open-university/

Number of US colleges and universities using each LMS as their primary system
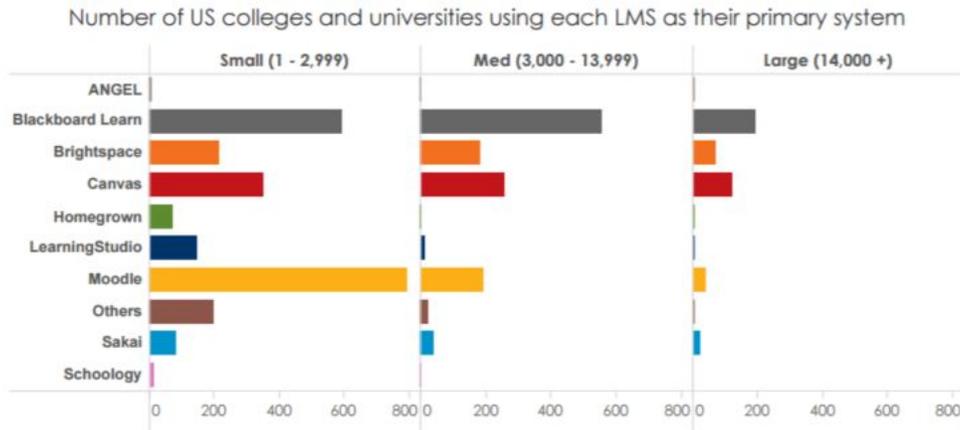
Figure 10 Spring, p. 18

This has consequences:

● Our size makes us a minority in the Moodle open source community. Development code "fixes" that address problems large-enrollment institutions have are not prioritized because so few others experience the problems UMN does.
● At our scale, we have few peer institutions with which we can share best practices and common solutions.[25] This puts UMN at more risk - we have few colleagues to confer with when problems occur.

More on technical challenges can be found below in section 5.2.

Generally, the use of Moodle among UMN's peer institutions is low – even among smaller institutions – as the section below describes.

5.1.3   Lack of Peer Institutions

UMN is the only member of the Big Ten Academic Alliance (formerly the CIC) to use Moodle. 64% of our BTAA peers use the Canvas LMS. (See the distribution below.)

BTAA Institution	Learning Management System(s)
University of Illinois	Blackboard
Indiana University	Canvas
University of Iowa	Canvas
University of Maryland	Canvas (rebranded as ELMS)
University of Michigan	Canvas

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[25] IT staff and leadership in higher-ed institutions maximize their resources and effectiveness by sharing knowledge of information technology practices, hardware and software, and vendors. This is done through IT professional development organizations and higher ed consortiums such as the Big Ten Academic Alliance (formerly the CIC).

Michigan State University	D2L
University of Minnesota	Moodle
University of Nebraska-Lincoln	Canvas
Northwestern University	Canvas
Ohio State University	Canvas
Pennsylvania State University	Canvas
Purdue University	Blackboard
Rutgers University	Sakai/eCollege (Blackboard and Moodle in smaller colleges and coordinate campuses—Moodle in their health sciences programs)
University of Wisconsin-Madison	Canvas

Among our Carnegie R1[26] (Research 1) peers, seven institutions use Moodle, and one uses multiple systems, including Moodle--only 6% of our R1 peers.[27] Of the 115 Carnegie R1 institutions, 42, or 37%, use Canvas.

That Moodle is the chosen LMS of only 7% of our R1 peers – and none of our BTAA peers – is a sobering data point. Conversely, when so many of our BTAA and R1 peers – world-class institutions, as we strive to be -- have gravitated to Canvas and seem pleased with this choice, attention should be paid.

5.2 Technical Challenges and Growing Expense[28]

There is a saying in information technology that any system or solution can be made to work – you just need unlimited time and money to make it so. For OIT, continuing to invest in an LMS that has difficulty accommodating the size and complexity of the University is becoming hard to justify, as well as increasingly expensive.[29]

An analysis by the Office of Information Technology (OIT)'s Architect and Systems Integration staff describes the UMN's Moodle installation as "running at a scale that Moodle's architecture is not

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[26] The Carnegie Classification of Institutions of Higher Education is the leading typology of American colleges and universities. It is the framework in which institutional diversity in U.S. higher education is commonly described (from http://carnegieclassifications.iu.edu).

[27] Brandeis University, California Institute of Technology, Louisiana State University and Agricultural & Mechanical College; North Carolina State University at Raleigh, University of California-Santa Barbara, University of Massachusetts-Amherst, University of California-Los Angeles (which uses multiple LMSs, including Canvas), University of Minnesota system.

[28] The information in this section is from Infrastructure-OIT Moodle Assessment, an assessment performed by Architect and Systems line staff in OIT at UMN.

[29] While it is necessary for this report to note the issues UMN's Moodle system has that would affect its growth and health into UMN's future, it is very important to note that these are not intended as criticism. Our Moodle system has served UMN very well for many years. It is the result of many good decisions made over the past several years – often the best decisions available – and it is a highly effective and esteemed result of the hard work of many talented staff.

intended to support."[30]

5.2.1 Moodle Lifecycle Process

UMN uses an instance-based, 6-year lifecycle model for Moodle. It works like this: the current system, or "instance," of Moodle hosts active courses for one year, then those courses are available online for 5 more years before being taken offline. As a result, UMN has 6 years of courses online at all times.

So each year, a new instance of Moodle, with new hardware and storage, and the newest version of Moodle, is spun up to host the current year's active courses. The figure[31] below provides an example.
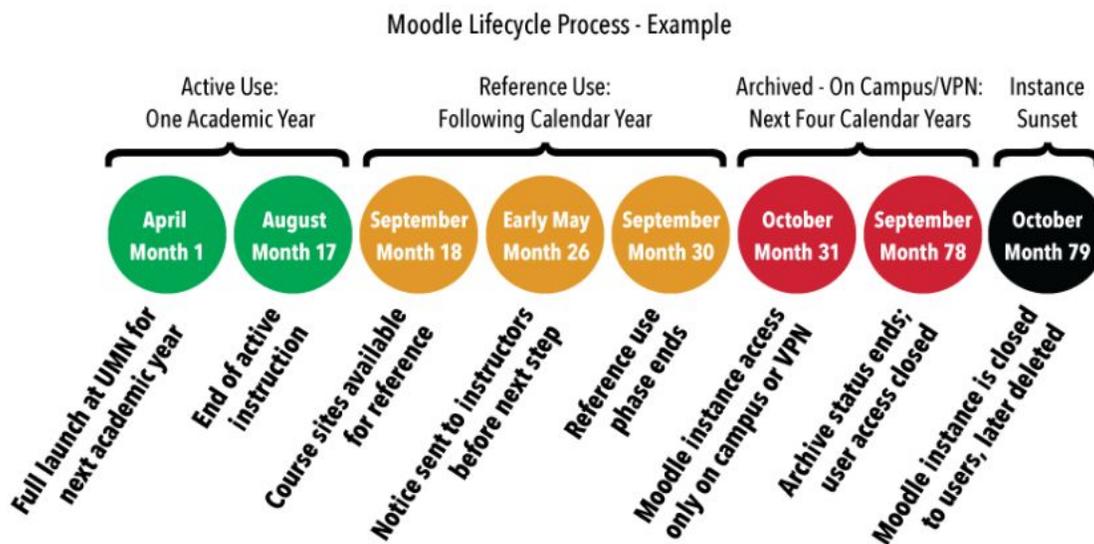
Figure 11 Moodle Lifecycle Process Example

This is in contrast to an "upgrade in place" model, in which one instance of hardware/software is used to host an LMS, and successive software application upgrades to that system (and subsequent semester courses) are all located in the same instance.

Keeping 6 years of different versions of Moodle systems operating requires dedicated staff and hardware. As each year's new cycle begins, the AT Tools team helps set a new version of Moodle into production and begins work on preparing the next instance – research, installation, and testing – of the infrastructure, application and integrations. Charting out staff costs as the use of Moodle has grown over the past 3 years, from FY2013 and projecting into FY2017, we find that, over these four years:

- use of Moodle will have grown by 34%;
- the number of staff supporting Moodle will have more than doubled, from 10 to 22 FTE; and
- the cost for staff to support Moodle has nearly doubled.

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[30] Infrastructure-OIT Moodle Assessment
[31] "Moodle Lifecycle Process, https://it.umn.edu/moodle-lifecycle-process .

AT Tools Service Growth

Fiscal Year	Moodle Course Count	Staff FTE	Student FTE	Total FTE	Staff Salary & Fringe	Student Salary & Fringe	Total Salary & Fringe
FY13	12,252	10.05		10.05	$1,025,253		$1,025,253
FY14	13,059	16.78	1.14	17.92	$1,505,503	$28,516	$1,534,019
FY15	14,282	16.82	1.66	18.48	$1,643,575	$41,453	$1,685,028
FY16	15,228	21.57	1.6	23.17	$2,002,194	$39,913	$2,042,107
FY17 projection	16,370	20.97	1.28	22.25	$1,964,163	$32,000	$1,996,163
4 Year Growth %	34%	109%		121%	92%		95%

Source: OIT service reporting YTD data

Figure 12 AT Tools Service Growth (Moodle)

Because of the instance model, the storage and computing costs increase annually as new academic years are brought online.[32]   Currently, UMN maintains 93 servers to house the current and past instances of Moodle.

5.2.2   Opportunity Cost

There is also an opportunity cost[33] associated with costs to support UMN's onsite Moodle implementation: UMN is investing significant resources just to keep the Moodle LMS running. As this section discusses, a still larger investment will be required in the future simply to keep it running at its current state. The investment of money, time, and staff expertise would be better spent on supporting the teaching and learning mission of UMN directly – growing into innovative areas to support teaching and learning, and creating and customizing a customized learning ecosystem that would support UMN's growth into the future.

5.2.3   Limits of Current Moodle System

UMN's current Moodle system has other limitations. Our scale originally dictated that UMN use dedicated physical database servers for Moodle. Physical servers are more costly to run and manage than using "virtual machines,"[34] which is OIT's standard approach. Five years ago, the technology of virtual machines couldn't handle the size of Moodle, but that has changed -- virtual servers can now scale to the same power and configurations as physical servers needed by Moodle.

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[32] The trend is documented for the past 8 years.

[33] "Opportunity cost refers to a benefit that a person could have received, but gave up, to take another course of action. Stated differently, an opportunity cost represents an alternative given up when a decision is made."
http://www.investopedia.com/terms/o/opportunitycost.asp

[34] "A **virtual** machine (VM) is an operating system (OS) or application environment that is installed on software, which imitates dedicated hardware." http://searchservervirtualization.techtarget.com/definition/virtual-machine

By using virtual machines, UMN's Moodle system would gain much better capabilities for high availability, disaster recovery, and dynamic resource allocation.[35] None of that is possible (or at least, is quite difficult) with the physical servers of our current Moodle system.[36]

In addition, as Moodle use keeps growing, we will hit a hard limit to what can fit into Moodle's single database—even when breaking it up into individual academic years, as the instance model does. If we wish to continue growing Moodle, it will "require significant investigation into alternative database solutions and/or modifying the core Moodle software."[37]

Other findings of the analysis by OIT's Architect and Systems Integration team:

- Moodle's storage architecture is designed for small, non-clustered[38] installations. UMN's scale prevents us from being able to operate in this mode.
- UMN recently purchased a $65K dedicated storage cluster for Moodle in order to protect other storage customers from its negative effects. This was done because of a file-locking mechanism in Moodle's design that caused the storage of other applications to go down when it shared the same storage cluster as Moodle.

Another limitation of UMN's current onsite Moodle system is that it will inhibit, or prevent, UMN's development of more advanced learning analytics capabilities.

The multi-instance approach greatly inhibits the ability to perform analyses that span multiple academic years: in the multi-instance model, the Moodle IDs for students and courses differ from year to year. Performing longitudinal analyses would require building and supporting a separate database with processes and logic to piece these data back together.[39]

In addition, "Moodle does not inherently provide detailed clickstream data.[40] This is critical for growing demand for predictive and deep dive analysis."[41]

The analysis concludes, "We're at the edge of what we can do with hardware/software/Moodle

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[35] "**High availability** refers to systems that are durable and likely to operate continuously without failure for a long time. The term implies that parts of a system have been fully tested and, in many cases, that there are accommodations for failure in the form of redundant components; **Disaster recovery** (DR) involves a set of policies and procedures to enable the **recovery** or continuation of vital technology infrastructure and systems following a natural or human-induced **disaster**; **Dynamic memory allocation** is a memory management technique in which a program can request and return memory while it is executing. In a virtualized environment, available memory on a physical host is pooled and distributed to virtual machines (VMs) that are running on that host when needed. If a virtual machine is not using all of the memory it's been allocated, the host may allocate one VM's idle memory to another VM."

[36] Infrastructure-OIT Moodle Assessment

[37] Infrastructure-OIT Moodle Assessment

[38] "A computer cluster consists of a set of loosely or tightly connected computers that work together so that, in many respects, they can be viewed as a single system... They are usually deployed to improve performance and availability over that of a single computer, while typically being much more cost-effective than single computers of comparable speed or availability." (Wikipedia)

[39] Infrastructure-OIT Moodle Assessment

[40] "**Clickstreams**...are the route that visitors choose when clicking or navigating through a site. A **clickstream** is a list of all the pages viewed by a visitor, presented in the order the pages were viewed, also defined as the 'succession of mouse clicks' that each visitor makes."

[41] Canvas does.

design as it is. Increased demand will require a significant research effort to identify new solutions."[42]

5.2.4   Comparison of Cost: Current on-site Moodle, MoodleRooms, and Canvas

A detailed analysis of the costs of three LMS systems follows – UMN's current onsite system, MoodleRooms hosted SaaS LMS, and Instructure's hosted SaaS LMS. Staffing estimates for MoodleRooms and Canvas are based on current staffing costs of supporting our onsite Moodle system.

LMS Decision, Steady State Summary, Year 6

Vendor Payments	Current Moodle	Moodlerooms SaaS	Canvas SaaS
	Cost Picture Year 6		
License / Membership	$0	$1,068,000	$1,145,000
Fees	$8,000[43]	$8,000[44]	$12,000[45]
Training	$0	$33,000[46]	$0
Support	$0	$0	$0
Implementation/Consulting	$0	$25,000	$0
Total Vendor Payments	$8,000	$1,134,000	$1,157,000

People	Cost Picture Year 6		
Application Management	$150,000	$0	$0
Business Analysis	$495,000	$385,000	$385,000
Database Admin	$60,000	$0	$0
Development	$342,000	$228,000	$228,000
Mgmt / Leadership	$213,000	$213,000	$213,000
Service Desk	$380,000	$380,000	$380,000
Training	$21,000	$21,000	$21,000
Total People	$1,661,000	$1,227,000	$1,227,000

Infrastructure Costs	Cost Picture Year 6		
Virtual Servers	$130,000	$0	$0
Database Servers	$65,000	$0	$0
Storage	$26,000	$0	$0
Total Infrastructure Costs	$221,000	$0	$0
Total All Costs	$1,890,000	$2,361,000	$2,384,000

Figure 13 Cost of Onsite Moodle, MoodleRooms SaaS, and Canvas SaaS systems

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[42] Infrastructure-OIT Moodle Assessment; this also refers back to the limitations imposed by continuing to use the physical servers of Moodle's original (and current) system; the task of moving from physical to virtual servers would also require a significant investment of staff time for research, testing, and implementation.

[43] Moodle Association Membership is 10,000 Australian dollars annually - currency valuation as of 10/21/16

[44] Does not include storage fees & costs for extra refreshes which are TBD.

[45] Fee for access to a test system.

[46] Annual fee for students to access training materials.

5.2.5 Consequences and Risk

5.2.5.1 Uptime and Downtime

The LMS has become one of the most critical systems at an institution of higher learning. At the same time, education has become much less bound to the clock, the calendar, and the physical space of a traditional center of learning. Higher ed institutions are under pressure to provide a teaching and learning environment that mirrors the ease, speed and reliability of a 21st century online experience. In short, students (and instructors) now expect easy, instant, and 24/7 access to the tools and content they need to teach and learn. Providing this type of online experience is extremely expensive and is likely the reason for the recent upsurge in college and university LMS moves to the cloud (85% vs 15% onsite – see section 4.1.2 above).

Planned outages for upgrades and maintenance must occur in a self-hosted LMS. In the past year, UMN's Moodle system has been down for a total of 12 hours of planned outages.

A self-hosted LMS system is also vulnerable to unplanned outages. While a second site is available at UMN for planned failovers, both are geographically close and could be impacted by a single event (e.g., a storm). The connections of Moodle's system to other onsite systems contribute to unplanned outages as well, as has happened in the past year when storage that Moodle used went down. In the past year, Moodle has had 38.8 hours of unplanned outages. Planned and unplanned outages for UMN's onsite Moodle system yield an uptime of 99.557%.

See the table[47] below for how UMN's uptime compares to two vendor-hosted systems, Instructure's hosting of Canvas, and MoodleRooms' hosting of Moodle. They appear extremely close, but note that when this percentage of uptime is extrapolated to actual time, the difference in uptime between our self-hosted UMN system and the two hosted systems is significant.

Metric	Uptime % (Unplanned outages only)	Uptime % (Planned & Unplanned outages)	
Moodlerooms	99.965%	99.900%	Moodlerooms level of 99.965 % uptime/availability gives following periods of potential downtime/unavailability: ● **Daily:** 30.2s ● **Weekly:** 3m 31.7s ● **Monthly:** 15m 20.4s ● **Yearly:** 3h 4m 4.9s

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[47] Uptime calculator at https://uptime.is/; from MoodleRooms SaaS presentation, Jeff Weber, 2/25/2017.

Canvas	99.996%	99.996%	Canvas level of 99.996 % uptime/availability gives following periods of potential downtime/unavailability: ▪ **Daily:** 3.5s ▪ **Weekly:** 24.2s ▪ **Monthly:** 1m 45.2s ▪ **Yearly:** 21m 2.3s
UMN Hosted Moodle	99.557%	99.162%	Moodle's level of 99.557 % uptime/availability gives following periods of potential downtime/unavailability: ● **Daily:** 6m 22.8s ● **Weekly:** 44m 39.3s ● **Monthly:** 3h 14m 9.8s ● **Yearly:** 1d 14h 49m 57.3s

Figure 14 Outage comparisons

The difference noted here signifies only a shift in technology and is in no way a negative comment on UMN's self-hosted system (or any other university's self-hosted system). This differences testifies to the quality of online hosting that is now available and provided by companies that make LMS hosting their core business – and so *do* spend significant dollars on highly specialized staff, hardware, and development specifically targeted at providing fast, stable, reliable and 24/7 system access. (The 3-hour Amazon Web Server outage of February 28, 2017 occurred during the writing of this report.[48])

5.2.5.2   Security Risk

As noted above in Section 5.2.1, UMN follows an "instance model" in which new servers are spun up each year for current, active courses, which those that house previous academic years of Moodle courses are still available to UMN instructors and students for four more years.

UMN's system administrators have devoted significant research and testing time to scan UMN's Moodle system for security. Additionally, University Information Security performed a high level security assessment of Canvas and Moodle Learning Management Systems. While details of that analysis are not provided here in order to prevent the introduction of additional risk, the analysis identified numerous security challenges with UMN's existing Moodle environment. Those challenges relate to maintaining compliance with the University's Information Security Policy.

6   CANVAS PILOT EVALUATION

6.1   EVALUATION METHODS

Usability data was gathered in two different sessions by Nick Rosencrans, User Experience Analyst,

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[48] The February 28, 2017 3.5 hour outage of Canvas, caused by a Amazon Web Server outage, occurred during the writing of this report. According to Instructure, "Long incidents like today's are very rare. We've built our six-year 99.9%+ Canvas uptime track record on strong performance by the AWS cloud…" For more, see Instructure Incident report.

OIT, using a cross-functional evaluation team. Team members developed realistic task scenarios and observed faculty (in the first study) and students (in the second) to help identify usability issues, which were then analyzed according to impact and difficulty to fix.[49]

Evaluation data for all three semesters was collected by Paul Baepler, CEI, via survey and focus groups for both faculty and students.

6.2 USABILITY EVALUATIONS

During the pilot, usability evaluations of Canvas were conducted for the faculty experience and for the student experience. Full reports are available at the links below.

> *Summary Report for Canvas Learning Management System Usability Evaluation* (faculty)
> *Summary Report for Canvas Student Experience Usability Evaluation* (students)

6.2.1 Faculty Usability Study

On October 13-14, 2015, a usability study was conducted through Usability Services in OIT, led by User Experience Analyst Nick Rosencrans. Goals of the study were:

- To identify issues that prevent users from completing their own tasks without outside help
- To explore what makes Canvas distinctive compared to other learning management systems
- To consider what specific features may be easily translated into the existing Moodle environment
- To decide upon changes to make to the spring pilot
- To assist with the development of the final report on the Canvas pilot

The usability team identified key issues that were referred either to the Canvas pilot project team or to Instructure for consideration. These are found on p. 6 of the Usability Evaluation Summary Report.

After participating in the usability study, participants were asked to select five words from a sheet of adjectives, a Desirability Matrix, describing Canvas based on their experience with it during the usability evaluation. The following were chosen most frequently among participants:

- Clean (4)
- Organized (4)
- Effective (3)
- Complicated (3)

Participants were also asked to rate Canvas on a System Usability Scale (SUS).[50] Canvas received an average SUS of 61.

6.2.2 Student Usability Study

On March 7, 2016, a usability study was conducted through Usability Services in OIT, led by User

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[49] Further details on data collection methods may be found in each usability report.

[50] The SYSTEM USABILITY SCALE (SUS) is the most widely used standard questionnaire for measuring the perception of usability. First developed in 1986, it has been used on software, websites, mobile phones, hardware, interactive voice response (IVR) systems and even paper ballots. It has been cited in over 600 research publications and is part of leading commercial usability-evaluation tools" (Usability Evaluation Summary Report, p. 7). While interpretation of the SUS depends on many factors, the average SUS score is 68.

Experience Analyst Nick Rosencrans. Goals of the study were:

- To explore what students encounter when first introduced to an unfamiliar learning management system
- To identify aspects of Canvas that lead students to feel confused, frustrated, or engaged
- To pinpoint which features of Canvas inhibit efficiency and familiarity of the course design, and could be hidden from view

The usability team identified key issues that were referred either to the Canvas pilot project team or to Instructure for consideration. These are found on p. 6-7 of the Usability Evaluation Summary Report.

After participating in the usability study, participants were asked to rate Canvas on a System Usability Scale (SUS). Canvas received an average SUS of 76.

6.3 USER ASSESSMENT – FACULTY AND STUDENTS

The following section summarizes results from the fall 2016 user assessment and system usability evaluations, provided in the reports below.

> *The Canvas Learning Management System: Instructor and Student Experience Final Evaluation January 2017*

Because user evaluation results of previous semesters were reported in detail in the UMN Canvas Pilot – 2015-16 Report, they will not be summarized below. Full evaluation reports from previous semesters can be found at the links below.

> *Fall 2015 – Instructor and Student Canvas Pilot Evaluation*
> *Evaluation of the Instructor and Student Experience of the Pilot of the Canvas Learning Management System Spring, 2016*

The fall 2016 pilot included 66 instructors[51] and approximately 5,005 students enrolled in 69 courses. Notably, the Rochester campus contributed a course to the Canvas pilot for the first time. One of the purposeful selections in this semester's pilot was an extremely large course (400+ enrollments) - Chem 1015 (682 enrolled as of end of semester). See Figures 15 and 16 below.

6.3.1   Information about Pilot Instructors and Courses

Instructors who participated in the fall 2016 pilot were nearly evenly split in terms of Canvas experience: 34 had taught in previous semesters of the Canvas pilot, while 32 instructors were new to Canvas.

As in the previous pilots, most instructors' courses were copied from Moodle to Canvas and each instructor and course were given individual support by academic technologists in OIT's Academic Technologies group; CEHD courses were supported by academic technologists in their college. The Duluth and Crookston campus courses also received support from their local IT staff.

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[51] This was the first semester that instructors were not provided with a monetary stipend for participating in the pilot.

Fall 2016 Canvas Pilot by Department

Figure 15

Fall 2016 Canvas Pilot by Campus
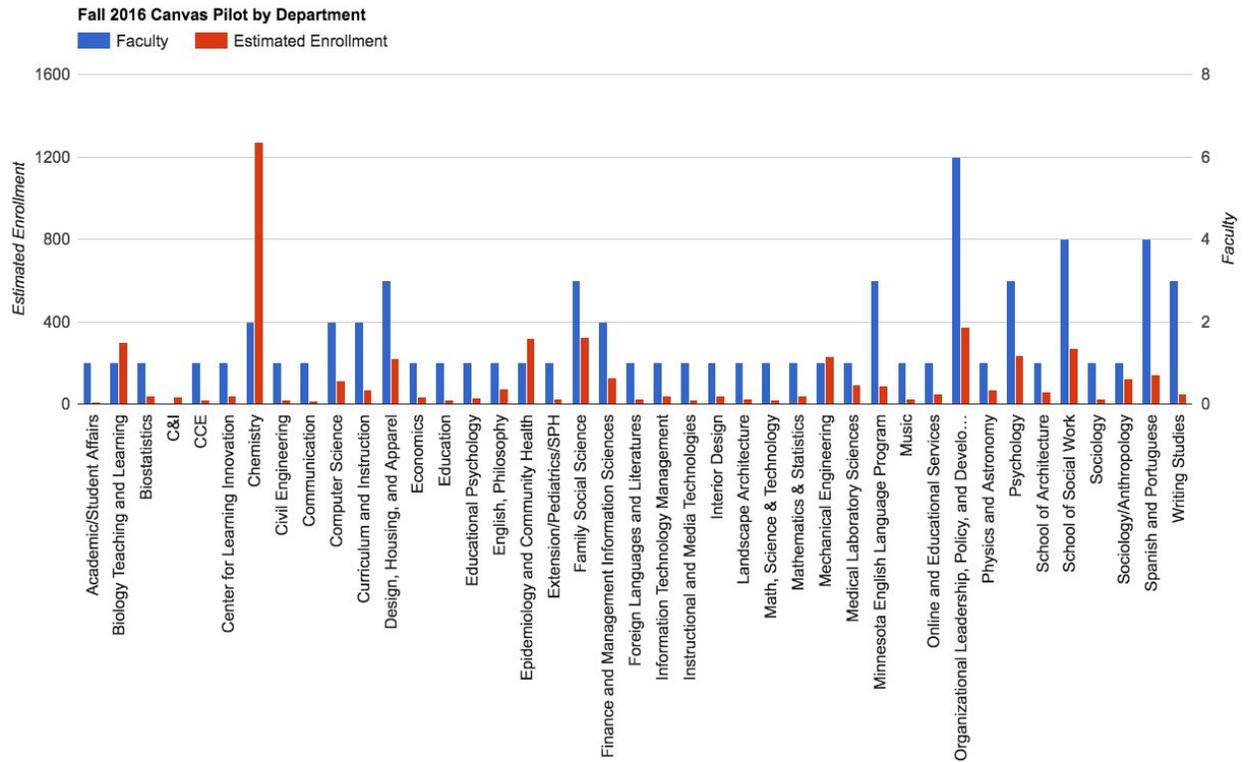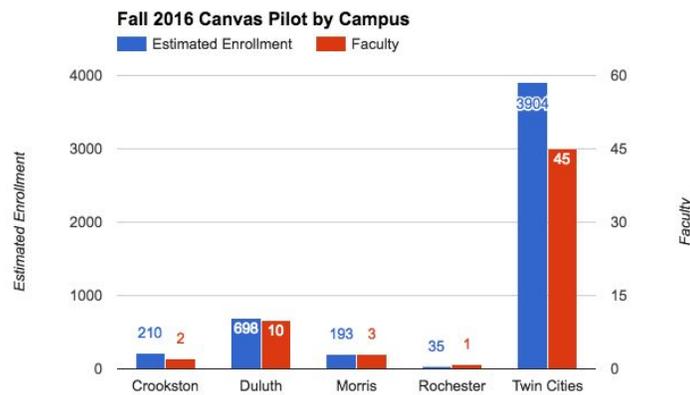
Figure 16

6.4 FALL 2106 INSTRUCTOR AND STUDENT EVALUATION

Assessment results from the most recent semester, fall 2016, are reproduced below verbatim from the report, *The Canvas Learning Management System: Instructor and Student Experience Final*

Evaluation January 2017 by Paul Baepler, Center for Educational Innovation.[52]

6.4.1 Data Collection Rate and Participant Characteristics

As in previous semesters, assessment was administered via survey and focus groups of Canvas pilot instructors and students.

Source	# of Participants	Response Rate
Instructor Survey Responses	43/76	55%[53]
Instructor Focus Group Participants	13	-
Student Survey Responses	1163/4099	28%[54]
Student Focus Group Participants	5	-

The courses were delivered in multiple formats and class sizes.

Table 2: Class Formats

Format	Total
Face-to face	24
Blend of face-to-face and online	10
Online	9

Table 3: Instructor Respondents by Course Size

Course Size	Total
0-20	11 (26%)
21-40	13 (30%)
41-60	4 (9%)
>60	15 (35%)

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[52] Where relevant and appropriate, differences in results between the fall 2016 semester and previous semesters are noted.

[53] The instructor survey response rate was lower in the fall 2016 semester compared to spring 2016. This is likely because it was the first semester of the pilot in which faculty did not receive a financial stipend for participation and completion of the survey.
[54] For replying to the survey, students were entered into a raffle to receive a gift card.

Students from around the system and at all academic levels participated in the survey.

Table 4: Student Respondents by Campus

Campus	Responses
Crookston	24 (2.0%)
Duluth	167 (14.4%)
Morris	27 (2.3%)
Rochester	19 (1.6%)
Twin Cities	926 (79.7%)

Chart 1: Student Respondents by Campus
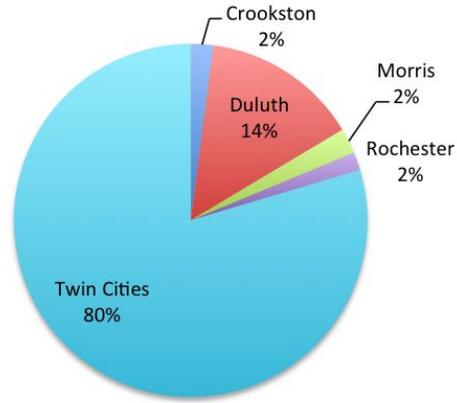
Table 5: Student Respondents by Academic Level

Level	Responses
Freshman	332 (29%)
Sophomore	234 (20%)
Junior	220 (19%)

Chart 2: Student Respondents by Academic Level

Senior	219 (19%)	
Graduate/ Professional	156 (13%)	
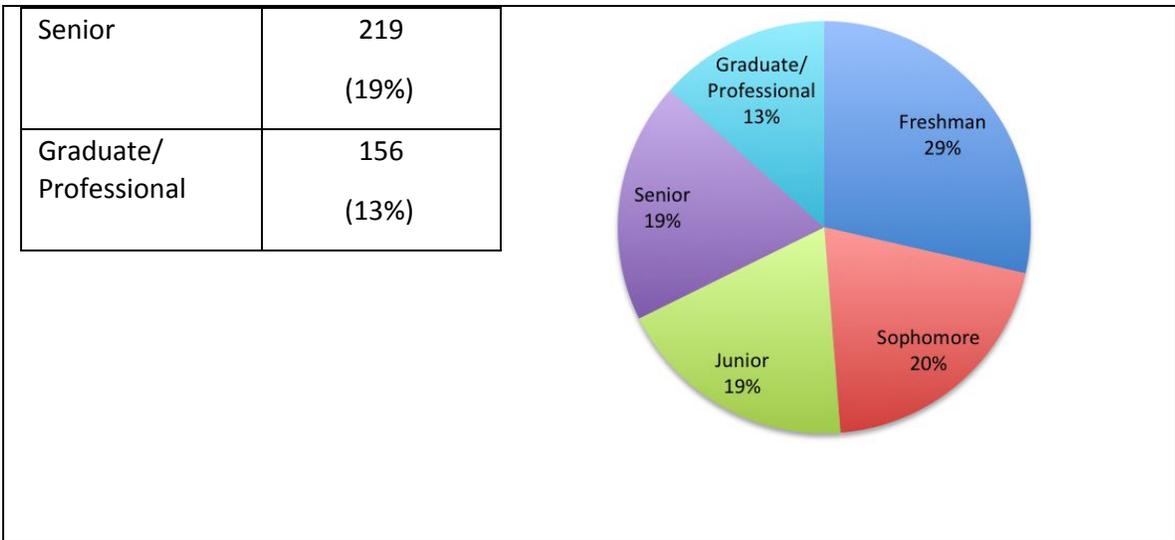
6.4.2 Survey Results

6.4.2.1 LMS Preference
Both students and instructors were asked which LMS they preferred. As in previous semesters, both groups expressed a moderate preference for Canvas over Moodle.

> Q. "Overall, which course management system helps you better to succeed in your classes?"
> [Chart 4] and "is better for your teaching?" [Chart 5]

Chart 4: Student LMS Preference
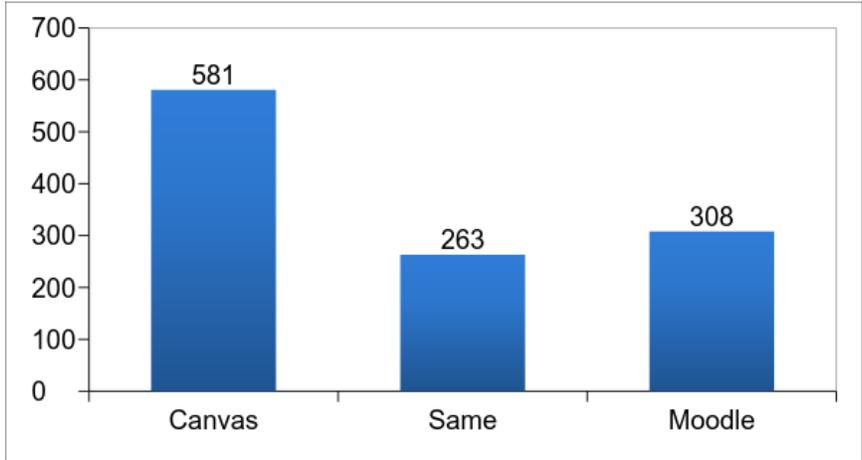
Chart 5: Instructor LMS Preference
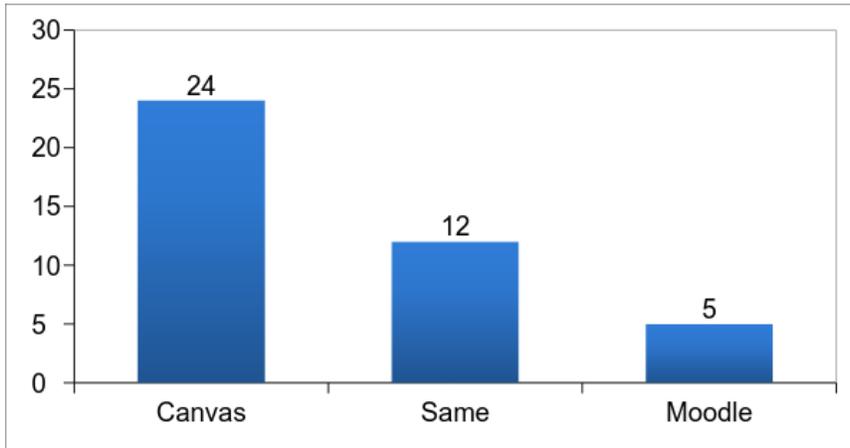
Table 6: Student and Instructor LMS Preference

	Canvas	Same	Moodle
Students	581 (50%)	263 (23%)	308 (27%)
Instructors	24 (59%)	12 (29%)	5 (12%)

Both students and instructors were also asked to choose a single learning management system. Again, both groups selected Canvas over Moodle. With this question, when compelled to choose one system or the other, the margin in favor of Canvas over Moodle is larger for both students and instructors: 60% of students and 79% of instructors said the University should switch from Moodle to Canvas.

> Q.*"In your opinion, should the University switch learning management systems?"*

Chart 6: Student -- Should the University Switch LMSs?
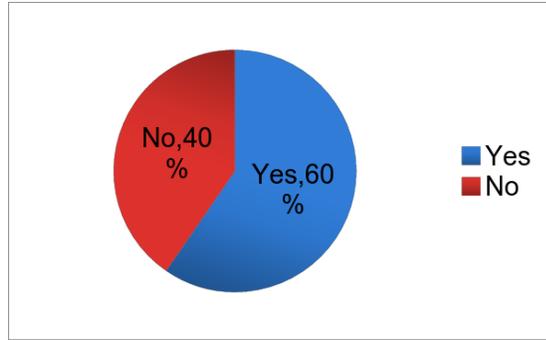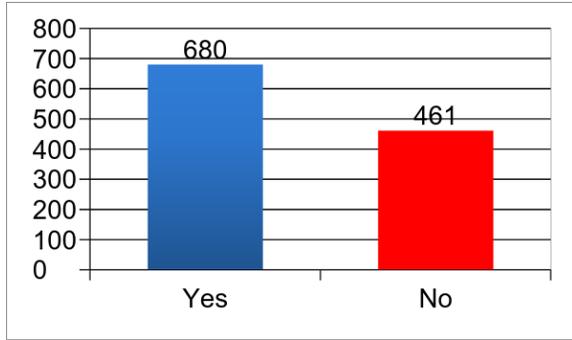
Chart 7: Instructor -- Should the University Switch LMSs?
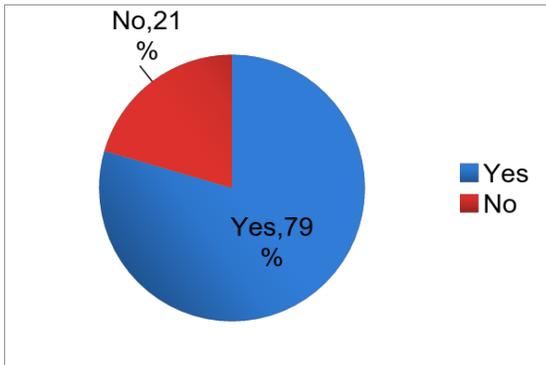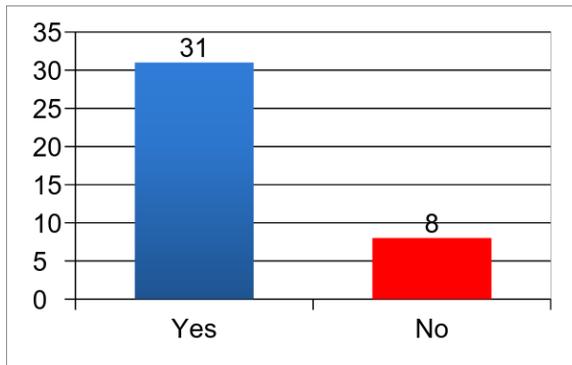
Table 7: Student and Instructor LMS Switch?

	Yes	No
Students	680 (60%)	461 (40%)
Instructors	31 (79%)	8 (21%)

6.4.3   LMS Feature Preference

6.4.3.1   *Student LMS Characteristics Preference*
Students were asked to rank LMS characteristics or features from a list generated by ATSS staff and to rate their satisfaction with Canvas and Moodle on each of these traits. The table below examines the differences in student ratings and presents them in the rank order of importance that students determined. In seven of the ten categories, students expressed more than a nominal difference between the two systems, but only one of these could be considered a moderate difference, and no differences were large.

Q. "*For each feature, rate your satisfaction for BOTH* Canvas and Moodle.*"* (*Please indicate*

51

whether you are Extremely satisfied=5, Somewhat satisfied=4, Neither satisfied nor dissatisfied=3, Somewhat dissatisfied=2, Extremely dissatisfied=1, Did not use=not counted.)

Table 8: Student – Feature/Characteristic Difference Between Canvas and Moodle

Rank*	Characteristic/Feature	Canvas	Moodle	Preference	Effect Size** (Meaningfulness of difference)
1	Tracking due dates	4.04 (1124)	3.61 (988)	Canvas	Small (d = 0.38)
2	Knowing what my overall grade is	4.14 (1114)	3.47 (990)	Canvas	Moderate (d = 0.59)
3	Accessing files my instructor has shared	3.99 (1126)	4.03 (994)	Moodle	None (d = 0.04)
4	Tracking individual grades	4.24 (1124)	3.75 (989)	Canvas	Small (d = 0.47)
5	Working with the User Interface (Look and Feel of the system)	3.91 (1111)	3.49 (973)	Canvas	Small (d = 0.38)
6	Managing and manipulating my files	3.81 (1011)	3.78 (929)	Canvas	None (d = 0.03)
7	Receiving notifications	3.89 (1104)	3.39 (932)	Canvas	Small (d = 0.45)
8	Interacting with course instructor	3.81 (924)	3.52 (816)	Canvas	Small (d = 0.28)
9	Interacting with other students	3.63 (835)	3.60 (800)	Canvas	None (d = 0.03)
10	Using the mobile app	3.53	3.27	Canvas	Small (d = 0.23)

| | | (495) | (367) | | |

*Rank is based on the features that students said were the most important.

**Effect size can be interpreted as a measure of meaningfulness of difference between ratings of features on each system. Effect size in this table is interpreted in this fashion: 0.2 Small, 0.5 Moderate, 0.8 Large (Cohen 1988).[55]

6.4.3.2   Instructor Survey LMS Characteristic Preference

Instructors were asked about their satisfaction with 19 LMS features (rank and satisfaction). In all but one case, instructors preferred Canvas features to those of Moodle, and they indicated more than a nominal difference between the two systems in 17 features. In general, instructors found more large and moderate differences between the two systems than students reported. As in Table 8, details in Table 9 present the difference in instructor ratings in the rank order of their importance as determined by the instructors.

> Q. "*<u>For each feature, rate your satisfaction for BOTH</u> Canvas and Moodle."* (*Please indicate whether you are Extremely satisfied*=5, *Somewhat satisfied*=4, *Neither satisfied nor dissatisfied*=3, *Somewhat dissatisfied*=2, *Extremely dissatisfied*=1, *Did not use=not counted*.)

Table 9: Instructor – Feature/Characteristic Difference Between Canvas and Moodle

Rank*	Feature	Canvas	Moodle	Preference	Effect Size** (Meaningfulness of difference)
1	Setting Up a Course	4.22 (41)	3.76 (37)	Canvas	Small (d = 0.44)
2	Assignment Creation & Management	4.18 (38)	3.58 (36)	Canvas	Moderate (d = 0.63)
3	Ease of Grading	4.37 (38)	3.09 (34)	Canvas	Large (d = 1.09)
4	Ease of Use	4.38 (42)	3.36 (36)	Canvas	Large (d = 1.03)
5	Gradebook	4.20 (35)	3.27 (33)	Canvas	Large (d = 0.84)
6	User Interface (Look & Feel)	4.32 (40)	3.11 (36)	Canvas	Large (d = 1.04)
7	Flexibility of Course Organization	3.70 (40)	3.38 (37)	Canvas	Small (d = 0.28)
8	Managing Course Files	4.07 (40)	3.31 (36)	Canvas	Moderate (d = 0.68)
9	Communicating with students/Announcements	4.34 (35)	3.62 (32)	Canvas	Moderate (d = 0.68)
10	Tracking Student Performance	4.12 (34)	3.53 (30)	Canvas	Moderate (d = 0.61)

[55] Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

11	Discussion Tools	3.83 (29)	3.52 (27)	Canvas	Small ($d = 0.26$)
12	Customizing the System	3.38 (34)	3.44 (32)	Moodle	None ($d = 0.05$)
13	Creating and Managing Student Groups	4.00 (23)	3.15 (27)	Canvas	Moderate ($d= 0.70$)
14	Student Preview	4.00 (32)	3.83 (29)	Canvas	None ($d = 0.16$)
15	Quiz Tool	4.10 (21)	2.96 (25)	Canvas	Large ($d = 0.96$)
16	Rubrics	4.32 (25)	2.73 (15)	Canvas	Large ($d = 1.34$)
17	Calendar/Scheduling	4.20 (25)	3.08 (24)	Canvas	Large ($d = 1.13$)
18	Mobile Experience	3.77 (22)	2.65 (17)	Canvas	Large ($d = 0.91$)
19	Branching Scenario Tools	3.75 (4)	3.17 (6)	Canvas	Moderate ($d = 0.54$)

*Rank is based on the features that instructors said were the most important.

**Effect size can be interpreted as a measure of meaningfulness of difference between ratings of features on each system. Effect size in this table is interpreted in this fashion: 0.2 Small, 0.5 Moderate, 0.8 Large (Cohen 1988).

6.4.4 Instructor View

6.4.4.1 *Instructor Comfort with Technology and Canvas*
As in Spring 2016, over 90% of instructor survey respondents described themselves as *comfortable* or *highly comfortable* with technology. The same proportion felt comfortable using Canvas within several weeks.

Chart 8: Instructors' Comfort with Technology
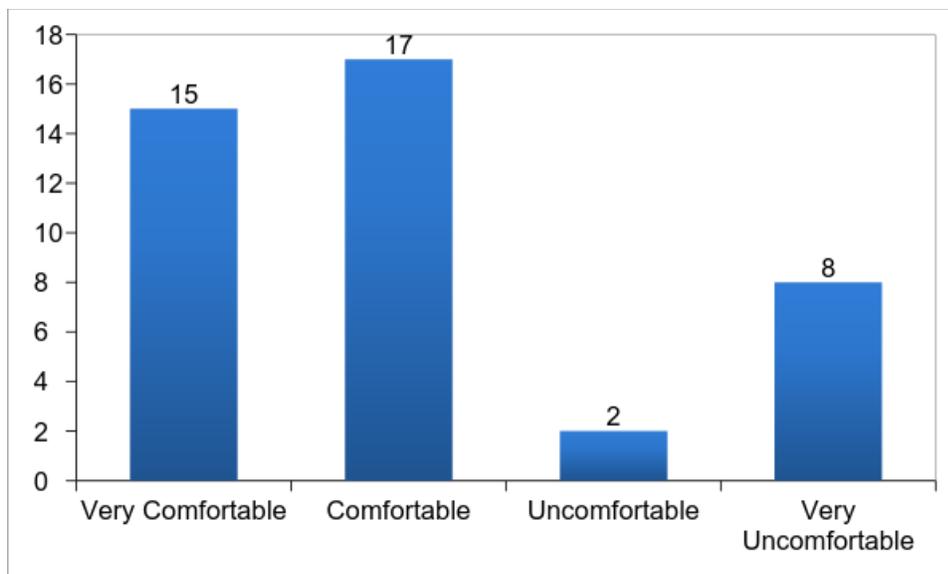
Chart 9: Instructors' Time Until Feeling Comfortable with Canvas
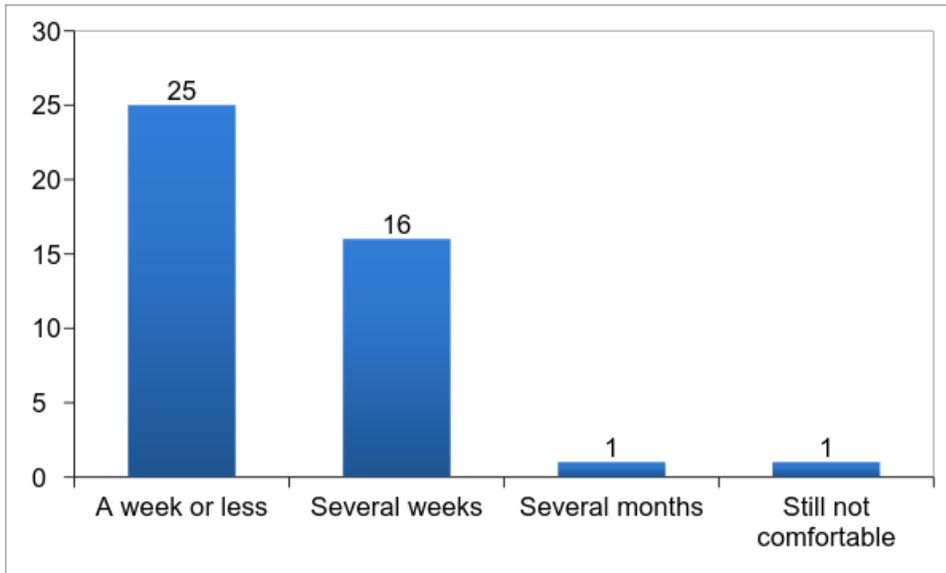
6.4.4.2 Instructor – Ease of Use, Adaptability, Teaching Fit

When asked to compare Canvas and Moodle in terms of their ease of use, adaptability, and teaching fit, instructors found Canvas to be easier to use, more adaptable to their needs, and better for their teaching.

Q. "*Which learning management system do you find easier to learn?*"

Chart 10: Which learning system do you find easier to learn?
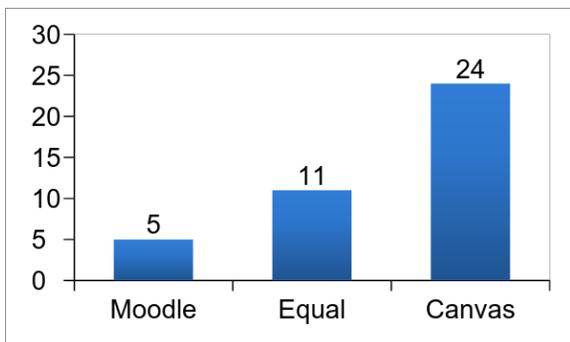
Q. "*Which LMS do you find most adaptable to your needs?*"

Chart 11: Which learning system do you find most adaptable to your needs?
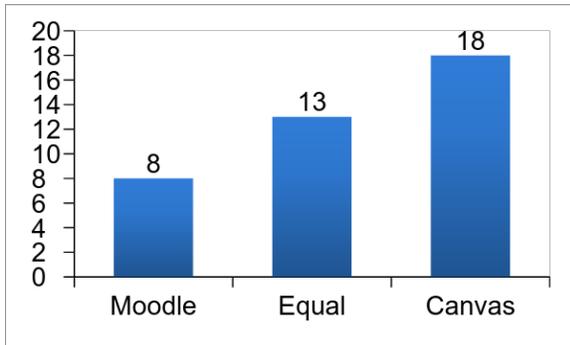
Q. "*Overall, which learning management system is better for your teaching?*"

Chart 12: Which learning system is better for your teaching?
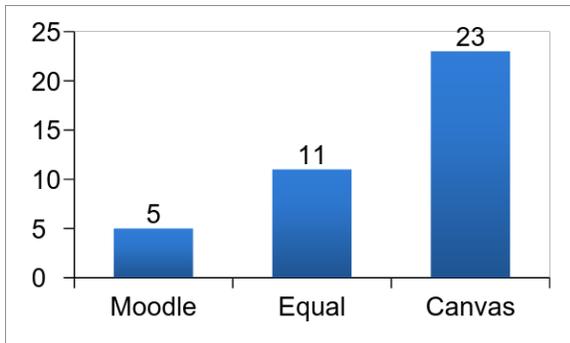
6.4.4.3   Instructor Opinion Regarding Canvas

In general, instructors held higher opinions of Canvas than Moodle in terms of the tool's efficiency, effectiveness, usefulness in teaching and learning, and instructors' enjoyment.

(*Please indicate whether you Strongly Disagree=1, Disagree=2, Neither Agree nor Disagree=3, Agree=4, Strongly Agree=5*)

Chart 13: Canvas increased my efficiency as a teacher.

Chart 14: Canvas increased my effectiveness as a teacher
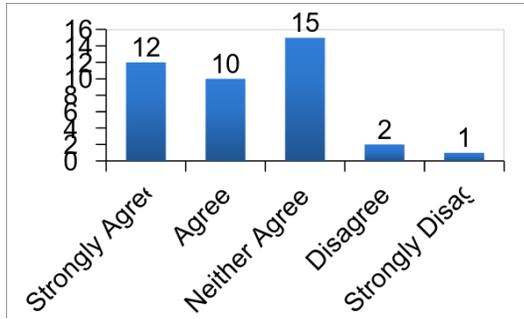
Chart 15: Canvas was a valuable aid to me in my teaching.
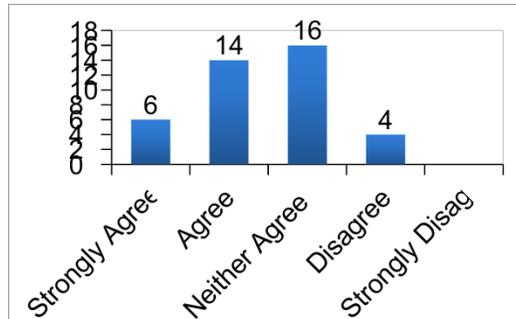
Chart 16: Using Canvas has been beneficial to my students' overall learning
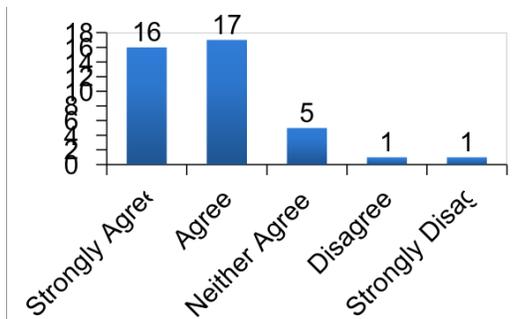
Chart 17: I have enjoyed using Canvas in my course.
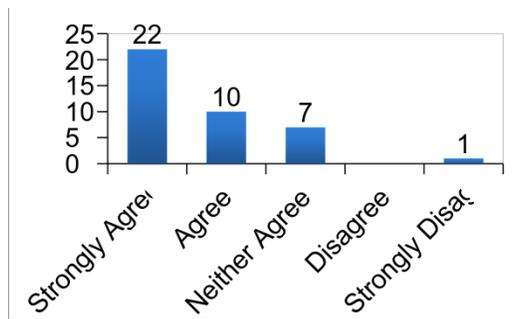
Chart 18: In the future, I would like to use Canvas in this course.

6.4.4.4   Selected Instructor Responses to Open-Ended Questions
What do you like most about Canvas?

- *"I like that it offers potentialities for further teaching tools such as video communication, interactive grading, webpage-based course with several pages that can be thematic, narrative etc . I feel that it has the potential to open up a new way of using online tools to teach."*

- *"If I had to pick exactly one thing... the biggest difference for me between Moodle and Canvas has been that Canvas supports group-work so much better (the grading and assigning of groups within a course).That's the very most helpful thing."*

- *"[Canvas] has a mobile app that needs development for administrative functions, but is generally pretty great."*

- *"I find it easy and much quicker to grade in Canvas and that my students can tell from the comments who is grading -- me or my TA. I also like that I can see on my main page when I have assignments to grade."*

What do you like least about Canvas?

- *"Discussion - no threading or clarity."*

- *"I really don't like that I can't track my students."*

- *"That it is created/owned by a for-profit company and is not open sourced."*

- *"Hard to figure out the grade book, to add quiz scores that are not done in Canvas."*

- *"Quizzing function is far less superior than Moodle -- I would not be able to teach 2 of my courses in the current Canvas LMS with the way that I administer the quizzes; Moodle isn't perfect, but at least I can get it to work!"*

Why do you prefer either Moodle or Canvas over the other?

- *"User interface is everything! Without a solid, easy to navigate interface, even the best system out there will fail. I feel Canvas is much better in this aspect."*

- *"I teach a course that includes community members. Moodle was next to impossible for them to navigate. They also had some access issues. These issues have gone away with Canvas."*

- *"I feel like I spend a lot of wasted time in Moodle waiting for things to load and waiting for things to respond. It's a real pain to arrange things or change things. Yes, it is a bit more flexible, but it is not as efficient."*

- *"Also, uploading grades in Moodle is *way* easier than in Canvas (where you need to download the file and upload it again)."*

- *"In the end, for me it is about student engagement and Canvas seems to better in that regard."*

- *"Speed grader [Canvas tool] is amazing."*

- *"Having frequently helped my faculty peers, I think when instructors wish to innovate or simply just try something new, Moodle sometimes seems like an insurmountable set of obstacles, whereas Canvas has a little more transparency."*

What more would you like to tell us about your experience using Canvas this semester?

- *"It's a new way of thinking about teaching, but if people only see an LMS as a supporting tool, they'll never use any given system to the max. Perhaps you can include a Canvas workshop as part of new faculty orientation. Perhaps you can offer College-based or even department-based Canvas workshops instead of having University-wide clinics. Instead of having faculty go to you, come to faculty. Come to department meetings and/or retreats... Whether to introduce Canvas briefly, or better yet to run a full-on workshop."*

- *"You need to account for this: there will be many faculty who don't want to put the time or effort, or are not interested in technology enough to explore Canvas to the full. There will be grumpy faculty! There will be faculty who want to do it, but won't be able to do it all at once."*

- *"Since technology by its nature is always changing, it's also a matter of you making it clear to faculty that no LMS will last forever and that change (whether upgrades or transitions to different LMS) is inevitable. And change can be a good thing if it helps faculty reflect on their teaching practices and improve them instead of repeating the same old models."*

- *"[Students] were also excited about the mobile interface (on the first day of class when I mentioned I'd be using Canvas, several of them grabbed their phones to see what the mobile site was like before I even mentioned it)."*

6.4.5 Student View

6.4.5.1 Student Comfort with Technology and Canvas
Ninety-eight percent of students reported that they were comfortable or very comfortable with technology, and 93% indicated that they were comfortable using Canvas within several weeks of the semester. Eighty-eight percent of students encountered fewer than three technical issues with Canvas through at least November 1, 2016.

Chart 19: Students' Comfort with Technology

59
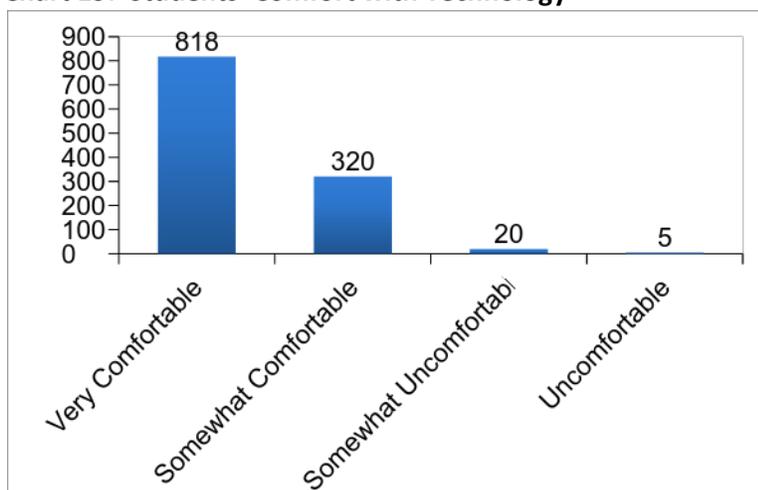
Chart 2: Students' Time Until Feeling Comfortable with Canvas
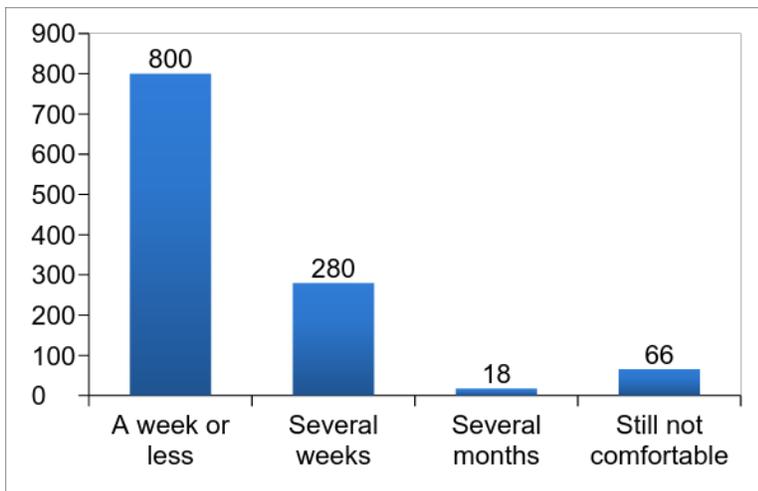
6.4.5.2   Student Technical Difficulties

Chart 21: Frequency of Technical Difficulties Among Students
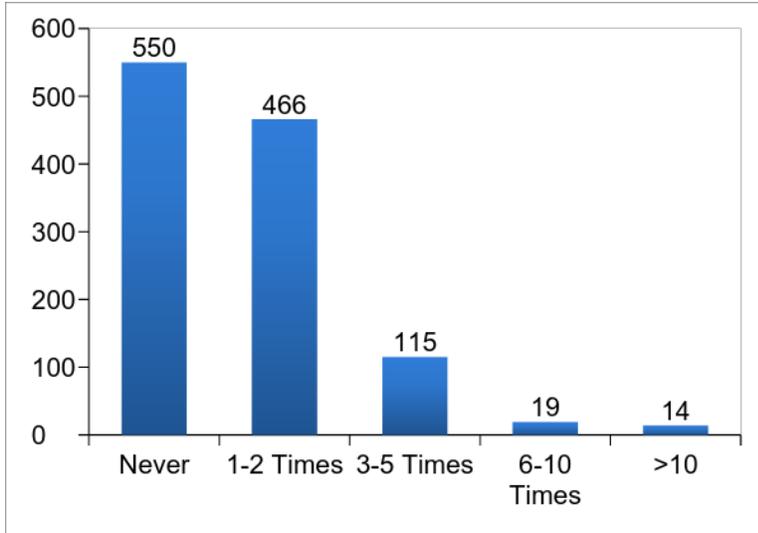
6.4.5.3   Student Device Use

Approximately half the students at one time used a smartphone to access Canvas, but 93%, for whatever reason, preferred using a laptop when working with Canvas.

Chart 22: Types of Student Device Usage with Canvas
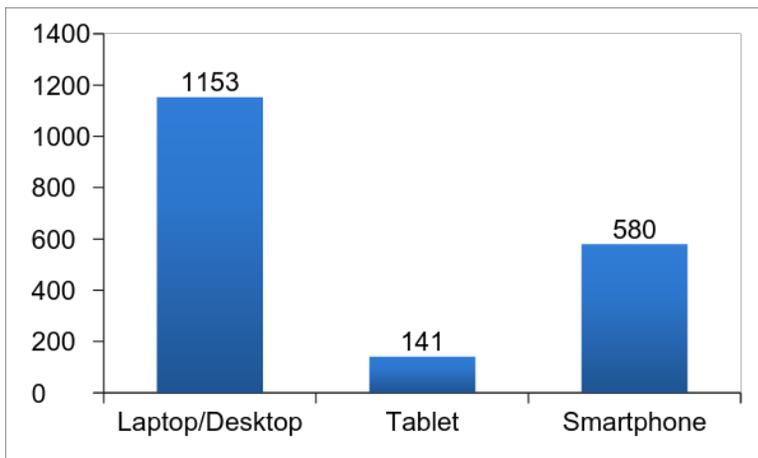
Chart 23: Preferred Device to Use with Canvas
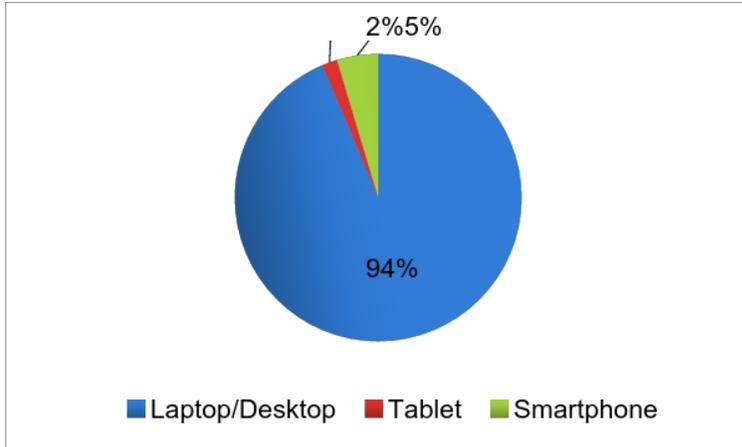
6.4.5.4 Student Satisfaction with the Mobile App

Approximately three-quarters of students were satisfied or very satisfied with the mobile app.

Chart 24: Student Satisfaction with the Canvas Mobile App
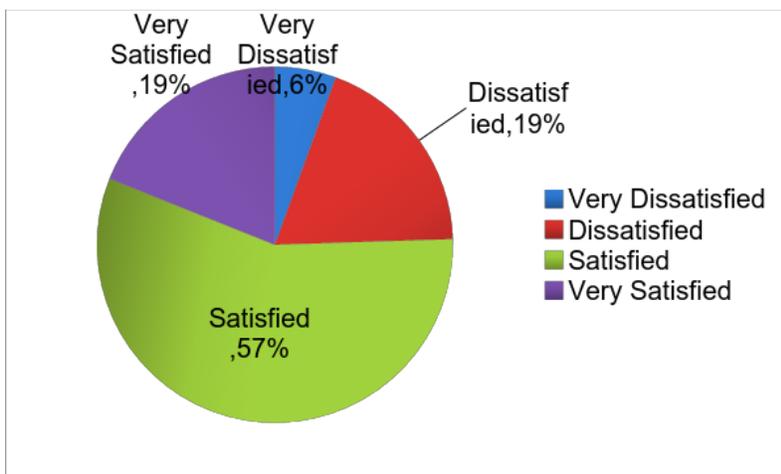
Selected Student Comments related to the Mobile App:

Positive

- *"There is a mobile app for canvas and that was a life saver!"*

- *"Canvas has an incredible mobile app."*

Negative

- *"Many of the files my instructor posts on canvas are impossible to view on the mobile app."*

- *"Canvas videos were inaccessible on a mobile platform."*

6.4.5.5   Canvas's Usefulness (Student)

When asked about the usefulness of Canvas in nine academic tasks or areas, students consistently found Canvas useful.

> Q. *Students – Canvas helps me to*

> (*Please indicate whether you Strongly Disagree*=1, *Disagree*=2, *Neither Agree nor Disagree*=3, *Agree*=4, *Strongly Agree*=5)

Chart 25: Students' Perception of the Usefulness of Canvas Features
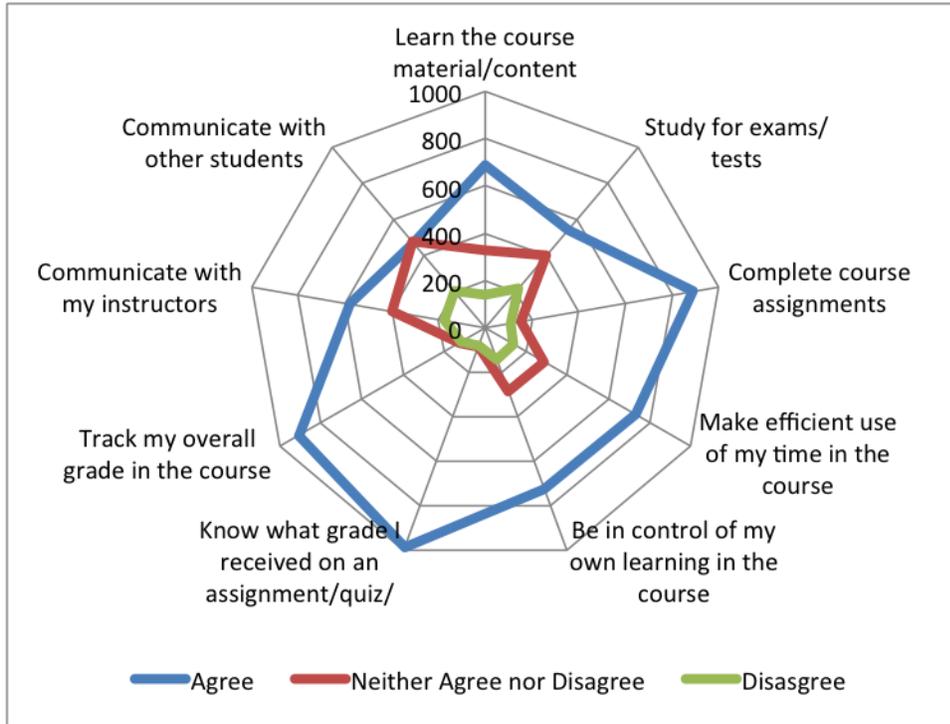
Table 10: Canvas usefulness for students

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Mean
Learn the course material/content	168 (15%)	518 (45%)	326 (28%)	104 (9%)	39 (3%)	**3.58**
Study for exams/tests	137 (12%)	403 (35%)	399 (34%)	168 (15%)	48 (4%)	**3.36**
Complete course assignments	314 (27%)	575 (50%)	155 (13%)	75 (7%)	32 (3%)	**3.92**
Make efficient use of my time in the course	246 (21%)	486 (42%)	284 (25%)	89 (8%)	50 (4%)	**3.68**
Be in control of my own learning in the course	222 (19%)	501 (43%)	288 (25%)	102 (9%)	42 (4%)	**3.66**

Know what grade I received on an assignment/quiz/ project	501 (44%)	486 (42%)	85 (7%)	50 (4%)	31 (3%)	**4.19**
Track my overall grade in the course	479 (42%)	429 (37%)	126 (11%)	80 (7%)	40 (3%)	**4.06**
Communicate with my instructor(s)	179 (16%)	402 (35%)	397 (34%)	135 (12%)	40 (3%)	**3.47**
Communicate with other students	131 (11%)	340 (29%)	478 (42%)	150 (13%)	54 (5%)	**3.30**

6.4.5.6   Selected Student Responses to Open-Ended Questions

Positive student comments about Canvas (versus Moodle)

- *"Canvas does do a better job at letting me see my overall performance in the classes at a glance, whereas in Moodle I had to fish around for that. I also appreciate that Canvas doesn't feel like it's pushing itself into my life as I did with Moodle. Canvas would be more like a friend, while Moodle is the annoying cousin that you just have to put up with."*

- *"The peer review process through Canvas is fantastic, as well; I can give direct feedback and attach edited documents without having to use Google Docs or email. Having all the communication take place on Canvas means the professor can see the reviews and discussions too, which has been an issue in the past on Moodle. The notifications are easy to customize as well, and will show you snippets of the new content. The only downside to Canvas is that the discussion threads are hard to follow."*

- *"Collaborative learning is SO much better on Canvas. Yes, Moodle has it's [sic] perks, but Canvas allows one student in a group to submit a single file for an entire group project. Submitting a GitHub URL as an assignment works magically in Canvas as opposed to Moodle, and previewing work from in Canvas is amazing."*

- *"Canvas is much more student oriented. It really helps students recognize due dates and follow the grades they receive on every assignment. Also Canvas gives students the ability to enter in a 'fake grade' into an assignment to see how their grade changes according to that specific assignment which is a feature I really like because it helped me track my grade much better. The Canvas layout is also much clearer, and easier for students."*

- *"The look and feel of canvas is much nicer and only glancing at a page you can tell what visual*

elements are the focus and you have a clue of what interactions with each of the elements might perform, but with Moodle not always."

Neutral student comments (Canvas versus Moodle)

- *"I can live with either. My success in the course does NOT depend on the learning management system."*

- *"I like both of them and so I don't see the reason to switch over to Canvas because it does not seem to have more benefits than Moodle."*

- *"I hate both of them to be honest, I don't think either is better than the other because they're both plagued with issues, they're just different issues. Find something completely different to use."*

Negative student comments (Canvas versus Moodle)

- *"Canvas wasn't revolutionary. The app is cool, but also hard to navigate. I don't think it is worth the headache of switching platforms."*

- *"I still print readings, and it is hard to print articles from Canvas. Further, there are so many glitches still. For example, last semester's assignments and due dates keep appearing in this semester's class causing much confusion."*

- *"The Canvas UI was not user friendly. The course discussions were very difficult to follow, and the Canvas system actually made me want to participate in the online course less.   I'm not in love with Moodle either, but it's a bit simpler and easier to manage. Most courses shouldn't really need all of the bells and whistles Canvas has."*

- *"Navigation throughout Canvas is very unclear. Going to weekly topics was easy, but then navigation within those pages was strange. For example, I would expect that using the "previous" arrow on week 5 would bring me to week 4, but instead, it brought me to slide show notes that I didn't even know were available to students until I stumbled onto the page accidentally."*

6.4.6   Canvas Instructor Focus Groups

Date: December 5, 2016, 1:00-2:00 p.m. & December 7, 2016, 10:30-11:30 a.m.

Location: Virtual using WebX & Walter Library 131

Procedural Note: This summary combines the findings of both instructor focus groups. The first was held online using the web conferencing tool, WebX, and consisted of instructors from Duluth, Rochester, and the Twin Cities campuses. An effort was made to recruit participants from Crookston

and Morris, but no one was available during the scheduled times. The second focus group was held face-to-face and was comprised exclusively of Twin Cities instructors. All focus groups were conducted by Paul Baepler (CEI) with Lauren Marsh (OIT) assisting.

6.4.6.1   Themes

In general, themes from this semester's focus groups were consistent with those from previous semesters. When asked about what they valued in Canvas, participants singled out **Speedgrader, rubrics, feedback tools on assignments/discussions**, **grading group assignments**, **scheduler**, and the **ease of editing** and adjusting content.

Instructors appreciated the flexibility to design the front page so that it feels more "custom-made."

Speedgrader and Providing Student Feedback

> *"For short, mini-presentations I used to write notes in a Google doc and translate notes into Moodle for feedback, and I found that I could have **Speedgrader** open and give feedback while the presentation is happening. I can enter information right away into a rubric while I'm remembering it and the experience is fresh. I don't need to do any extra work to give them this immediate feedback on mini presentations. It's possible that it could work in Moodle, but I have the sense that Speedgrader is what is enabling that."*

> *"Canvas provided an opportunity to **share feedback** between students on student presentations (particularly on mobile devices), and students expressed how helpful it was to read their colleagues comments so immediately. And it completely changed the tenor of the class."*

> *"The support for rubrics encouraged me to **do more with rubrics**. And it's clear that the students have been looking at the rubrics because they asked about it the one time I didn't have one set up for an assignment. "*

> *"Canvas [Speedgrader] is **changing the way I respond to minor writing assignments**. Typically what you would do would be to maybe give students a few summative comments at the end of a piece, but because Speedgrader makes it so easy to make comments without having to download all of the documents, I tend to be more specific about the comments I made within the document itself in addition to the summative comment at the end, and it doesn't take a ridiculous amount of time to do that."*

> *" The degree to which you can comment on small writing assignments is really important, not only for writing courses but for writing across the curriculum, and that it is so much easier to do on Canvas than it is in Moodle is to me a high selling point   .Canvas invites you to comment. It's more conversational. You have that document opened up **you're more inclined to make comments as you go** and then have those summative comments. With Moodle, I don't do that so much with the smaller assignments. You have to download them, open each one as a document, comment, and re-upload them as a file and it's ridiculously time consuming."*

> *" It doesn't matter what a learning system does. If a student isn't using it, they can't benefit from it. **Canvas engaged students and they used it more**, which means that the good stuff like feedback and dialogue between student and teacher can be much more potent."*

6.4.6.2   Canvas and Moodle Contrasted

> *"Canvas is like an iPhone app. You press an icon, and it pretty much works. With Moodle, there are so many options, but I don't know what they all do."*

> *"I felt like with Moodle everything is 20 mouse clicks and with Canvas everything is two."*

> *"Moodle 'feels' old and built under a different pedagogical paradigm and Canvas was built under the paradigm of mobile technology and cloud."*

> *"Regarding Canvas, I am happy that my students are happy [using Canvas]."*

> *"Canvas seems more like social media; it is arranged more like 2016."*

> *"Canvas looks cleaner. It looks more like something my students will want to use."*

> *"The things that I have to do most often are much easier to do in Canvas, such as fiddle with grades. Little things like that are a million billion times easier in Canvas."*

> *"As an instructor and as a course designer, I feel more empowered to try things out on my own. I use a lot more features—that I think are also available in Moodle—but I felt more comfortable playing around figuring it out in Canvas. I think there are so many [too many] options in Moodle that you look at it and say, 'I don't know.' **There are fewer options in Canvas, but I think more instructors would be more autonomous in designing and managing their courses** than they would be in Moodle and need less help. There are fewer options and maybe it's clearer what those options actually do."*

> *"I have a very limited use for all the bells and whistles it offers, but as somebody who really uses it just for gradebook management and course content delivery, **Moodle does just fine.**"*

6.4.6.3   Pedagogical Implications for Canvas

Increased grading reliability

In situations with multiple instructors or TAs, several graders can contribute feedback or assessment ratings to an assignment. For example, in situations in which a TA might be struggling with how to grade an assignment, she can ask another instructor to look at the assignment and the grading/feedback that has already been done in Canvas.

> *"Sometimes we can come together with the TAs and discuss the ones that they're really struggling with, and we can all look at the same one at the same time. And we'll also do it asynchronously when someone has a question and asks if someone else can look at this particular student to see what I've already done. **It's just so much easier and a lot less trouble for a TA to communicate with other TAs and us about how to best grade something**."*

Perception that Canvas supports introverted students

> *"[Canvas] feels more visually accessible and engaging. Made it easier for collaborative work and more introverted students seem more comfortable with engaging the class discussion. Because it's easy to access 'mobilely,' it has allowed me to give quick and insightful comments right away and then I'm getting more feedback back and forth. **The feedback bolsters their***

confidence and [introverted students] seem more easily able to lead in this applied course."

Anecdote: Instructor attempted new assignment in large lecture course.

One instructor mentioned that she tested the rumor/promise that Canvas would make grading easier by assigning a project in her large lecture (~200 students) course. This was the first time she attempted this type of assignment in this size course. She found that the grading was easier to complete and more reliable, and she was extremely content with the student outcomes:

> *"Canvas made grading easy because all the projects were in the same place (on the canvas site) and we could each see any of them, and we could each put our comments and see each other's comments on any of them, and we could do this while we were grading without the students seeing the scores. By doing this - -by looking at each others' scores and comments, we were able to come up with reasonable reliability in our grading. (We would just email each other saying -- what do you think of what I put on Student X's project -- was I too hard on him, etc -- and everyone would be able to see the project and the comments) ."*

> *"It would have been a nightmare juggling projects if they were turned in in a different way, whether that was on paper, or by email, or through a Google doc. It would have been hard to keep track of those, we wouldn't each have access to all of them particularly easily, and it would have been impossible to see each other's comments."*

> *"I would also add that I love what the students did with these projects. There is a huge variety of different health problems targeted, all different media. There are short films, websites, Instagram sites, blogs, posters, pamphlets, etc. Someone made a video game (sort of), and one student wrote an original song, which he submitted as an mp4 so I could hear it, along with a 38 page score for it in 6 instruments."[56]*

6.4.6.4   The Critical Need for Instructional Support

> *"If they do choose Canvas, I would strongly advocate that they have to give support to the faculty who are having to learn Canvas."*

> *"If people think that systems are going to change 'every five minutes,' then people will stop investing in the change."*

> *"If people are there to help carry the luggage, then maybe the cost of moving isn't so high. But if people think that they have to break it all down and carry it over, then some people are really going to get grumpy about that."*

6.4.6.5   Challenges with Canvas

Instructors mentioned that the **student view that instructors see does not accurately reflect what the actual student sees**. Also, several instructors remarked that it was difficult to know exactly what notifications and announcements Canvas was making. They would like more control over what the students see or what they are informed about.

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[56] This quote was taken from a follow-up email exchange that took place after the example was mentioned in a focus group.

Quizzing, when designed for "mastery" such that content is contingent upon completion at a particular level of ability, is not supported.

In Canvas, it's **difficult to upload a spreadsheet with a set of grade scores**; though, because one can easily search for students in Canvas, it's **easier to change a single grade** (a student's excused absence, for example).

Taking attendance didn't work consistently on the mobile app.

SCORM compliance wasn't fully integrated and there was no good workaround. This can be a fatal flaw for instructors who rely on SCORM (implemented in this fashion) for course interactions.

iClicker integration is particularly awkward. VideoANT isn't well integrated in Canvas.

Instructors mentioned that they **couldn't easily track students**. For instance, Canvas doesn't seem to track "over time" or with a timestamp. Access reports are very limited; they just tell you the last time something was accessed; thus you don't know if a student accessed something before a deadline or if they also tried more recently to access something after the deadline. **Moodle's student tracking, on the other hand, works fine**.

Self-assignment to groups has been confusing, and the auto-group function doesn't make a connection to previous groups (so that groups don't repeat the same members in subsequent groupings).

6.4.6.6   Challenges with Moodle

> *"It is so easy to accidentally click on something in Moodle and then you need to go and fix it in four places. A number of things need to align in order for things to work the way you expect it to work. In Canvas, there are fewer pitfalls."*

6.4.7   Canvas Student Focus Group

Date: December 9, 2016

Time: 10:00-11:00 a.m.

Location: Walter Library 131

Procedural Note: The student focus group was conducted with randomly selected Twin Cities students in the pilot courses; thirty responded from a random list; nine were invited and five participated. The session was conducted by Paul Baepler (CEI) with Lauren Marsh (AT-OIT) assisting.

6.4.7.1   Themes

Students appreciated the **clear organization** and formatting in Canvas. They singled out the tabs for navigation. They mentioned it was easier to **find new grades**, both in the web format and in the mobile version upon receiving a notification.

> *"It's kind of superficial, but it's definitely easier to navigate in Canvas, and if you're not going to miss something by scrolling all the way to the end of the page as you do in Moodle, it just makes it easier."*

"I don't want added stress of figuring out where do I actually find something. I think making the program [Canvas] as easy as possible, that only makes it better."

Students commented on the integration of tools within Canvas. They valued the ability to **conduct a peer review entirely within the system** (including having the rubric in Canvas and making comments within the tool).

Although students mentioned that the **discussion board** looked better than in Moodle, it was **difficult to follow**. The nesting was difficult to track because the levels of indentation were small in Canvas.

6.4.7.2 Appearance

Several students commented on the appearance of Canvas. They described it as seeming "modern," and this was consistent with the instructors' general impressions.

"Canvas is kind of like an app. The way Canvas is set up is the way mobile web sites are set up . You don't have to zoom in and try to tap on the right thing. That's super annoying, and I've tried to do that with Moodle on my phone. It's too frustrating."

Students also mentioned that it was easy to lose track of information or the instructor's directions that they needed in Moodle but the organization scheme in Canvas made germane content more prominent.

6.4.7.3 Pedagogical Implications for Canvas

Students mentioned that **group work in Canvas was easier to accomplish because of administrative efficiencies**. For instance, once the instructor defined the group, all those in the group received credit for a project if anyone in the group uploaded the finished project. Instructors could also see what was happening on a project as it was developing.

Students mentioned that it was motivating to see that their list of "upcoming assignments" gradually decreased as they accomplished each task.

6.4.7.4 Importance of Instructor and LMS

Students were keenly aware that the value of a learning tool depends upon the instructor's ability to use it.

"I hope there is a chance if you do a switch to have renewed training, or make templates for [instructors] or really short best practices or something. Even if it's one page and they don't make use of all the relational capabilities in Canvas and it has all the assignments for the entire semester, that would be super helpful."

"I've had plenty of professors say 'we care about you, we want you to do as well as possible' but if you want us to do as well as possible, then you need to use the interface to its fullest capability so that it's as easy for us [to navigate and understand what is expected] as possible."

"If professors know what they are doing on the web site, I think it will   reassure students that

everything is planned   . It will be easier for students to transition to a new system. If they do it well, then students will think, 'wow, this is great.'"

*"**I guess** [the decision on whether or not to switch LMSs] **would depend on how interested instructors would be in learning how to use it**. I think Canvas is a better system, but my instructor was very interested in learning how to use it   . If you have every single professor moving to Canvas and some don't care to learn how to use it, it could be a mess."*

7   CANVAS: TECHNICAL ISSUES AND CONSIDERATIONS

Because the previous pilot report detailed the Canvas technical review in full, what follows is a brief summary of that review, updated to include the fall 2016 semester. Please see the following reports for comprehensive details of the technical analysis of Canvas, in all areas covered in this section.

Canvas Technical Evaluation (2015-2016)

Canvas Technical Evaluation (Fall 2016 Public)

7.1   ARCHITECTURE

Instructure provides a cloud-based, hosted solution for a learning management system through Amazon Web Services. This includes load balancing, elastic scaling, and disaster recovery[57] around their primary service offering, Canvas.

In addition to Instructure's core course management system offering, the Canvas application ecosystem incorporates a suite of optional integrated systems that extend the LMS's core functionality, including a learning content management system (Commons), an electronic portfolio system (ePortfolio), a learning analytics datastore with associated APIs (Canvas Data), among others.

In contrast with the side-by-side upgrade process currently employed with the University's Moodle offering and the cadence release model of Blackboard's Moodlerooms, Instructure employs a continuous delivery, upgrade-in-place strategy. Long-term advantages include a common production environment and stable user identities within the system; however, it also introduces complexities and challenges in dealing with a 3-week change cycle with limited options to control.

7.2   CANVAS/MOODLE ONSITE/MOODLEROOMS RELIABILITY

Overall, Canvas availability and performance has been good during the pilot period. Although a number of outages and periods of degraded performance were recorded during the pilot period (including several with durations of greater than 60 minutes during peak usage periods), few of these incidents led to support tickets and overall uptime exceeded 99.996%.

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[57] "A **load balancer** is a piece of hardware (or virtual hardware) that acts like a reverse proxy to distribute network and/or application traffic across different servers. A load balancer is used to improve the concurrent user capacity and overall reliability of applications"; "**Elastic** computing is a concept in cloud computing in which computing resources can be **scaled** up and down easily by the cloud service provider. **Elastic** computing is the ability of a cloud service provider to provision flexible computing power when and wherever required"; "**Disaster recovery** (DR) involves a set of policies and procedures to enable the **recovery** or continuation of vital technology infrastructure and systems following a natural or human-induced **disaster**.

Metric	Uptime % (Unplanned outages only)	Uptime % (Planned & Unplanned outages)	
Moodlerooms	99.965%	99.900%	Moodlerooms level of 99.965 % uptime/availability gives following periods of potential downtime/unavailability: ● **Daily:** 30.2s ● **Weekly:** 3m 31.7s ● **Monthly:** 15m 20.4s ● **Yearly:** 3h 4m 4.9s
Canvas	99.996%	99.996%	Canvas level of 99.996 % uptime/availability gives following periods of potential downtime/unavailability: ▪ **Daily:** 3.5s ▪ **Weekly:** 24.2s ▪ **Monthly:** 1m 45.2s ▪ **Yearly:** 21m 2.3s
UMN Onsite Hosted Moodle	99.557%	99.162%	Moodle's level of 99.557 % uptime/availability gives following periods of potential downtime/unavailability: ● **Daily:** 6m 22.8s ● **Weekly:** 44m 39.3s ● **Monthly:** 3h 14m 9.8s ● **Yearly:** 1d 14h 49m 57.3s

Figure 17 Outage comparisons

An analysis of our onsite Moodle system's planned and unplanned outages reveals 42.4 hours of planned outages and 44.9 hours of unplanned outages in the past year (January 1 through December 31, 2016). See the table[58] above for how UMN's Moodle system uptime compares to two vendor-hosted systems, Instructure's hosting of Canvas, and MoodleRooms' hosting of Moodle.

Uptimes for each system appear extremely close, but note that when this percentage of uptime is extrapolated to actual time, the difference in uptime between our self-hosted UMN system and the two hosted systems is significant.

7.3 FUNCTIONALITY AND USABILITY

Canvas's tools and features met or exceeded virtually all of the requirements for the functional areas defined by the technical team. It offers the functionality and usability that is needed and expected from a LMS (see Canvas Technical Evaluation (Fall 2016 Public), section 3).

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[58] Uptime calculator at https://uptime.is/; from MoodleRooms SaaS presentation, Jeff Weber, 2/25/2017.

7.4 Integrations

Canvas offers the necessary technology to allow integrations to University systems (see Canvas Technical Evaluation (Fall 2016 Public), section 4), University-developed tools, and third-party tools Canvas Technical Evaluation (Fall 2016 Public), section 5.5).

7.5 Support for Integrated Systems and LTI Standards

Instructure's design strategy for Canvas has been to concentrate on the application as a learning platform, a solid hub application featuring a discrete core of critical course-management functions and a suite of standards-compliant program interfaces and vendor-supplied optional functions that enable an institution to customize the LMS to address campus-wide needs, or an individual instructor to extend her or his class by adding external tools to a course site using Instructure's integrated app store-like EduAppCenter.

For a list and details of systems that were integrated with Canvas for the pilot, support details, and LTI integrations' outages during the pilot, see Canvas Technical Evaluation (Fall 2016 Public) section 4.

7.6 Support for Critical Integrations

During the Canvas pilot, integrations were made between Canvas and UMN's authentication (login) service, PeopleSoft for student and instructor enrollment and updates, and API integration to allow easier interactions between courses and enrollments online. For details, see Canvas Technical Evaluation (Fall 2016 Public), section 5.

7.7 Instructure Administrative and User Support

From 14 August 2015 through 31 December 2016, University of Minnesota users initiated a total of 221 help requests with Instructure across a range of communication modalities (chat, telephone, and Web form).

Instructure has typically picked up all requests well within SLA limits and addressed users' questions in a timely manner; follow-up customer satisfaction survey scores have ranged from 89–96%, with a monthly average CSAT rating of 92.40%. Instructure support agents and engineering staff members typically identified the source of an issue and (when possible) proposed a workaround within 24 hours; when a workaround was impractical or a problem was identified in code, a fix was typically deployed within one three-week development cycle of the first report of an incident. See Canvas Technical Evaluation (Fall 2016 Public), section 7.

7.8 Course Transitions from Moodle to Canvas

Although the Moodle MBZ backup file format is not an interoperable standard, Instructure provides a converter facilitating the import of Moodle content and activities into a Canvas course site. In practice, this process proved efficient and relatively problem-free, requiring only that instructors or course designers re-organize and contextualize the imported course content.

The primary issue encountered with migration affected courses with large and complex quiz question banks—quiz instruments themselves imported cleanly but, owing to issues with standards used to

encode Moodle questions and quiz instruments, hierarchized question banks and some question assets (e.g., embedded images, audiovisual recordings, etc.) do not. In those instances, the pilot support team used Respondus's Quiz-Builder functionality to translate Moodle course exports into Canvas question banks.

7.9 ANALYTICS AND REPORTING

Numerous pieces of analytics and reporting functionality are scattered across the Canvas interface and APIs. This section will be divided into three sections: student-facing, instructor-facing, and administrator/researcher-facing.

7.9.1 Student-Facing Analytics and Reporting

Students have access to a grades page that reports on all of their scores for the course. This page is also editable to allow "what if" analysis of the effect of various assignments on the final course grade.

7.9.2 Instructor-Facing Analytics and Reporting

The instructor has access to a course-level summary analytics page that provides a histogram of participation and page views, an overview of assignment submissions (missing, on-time, late), and a set of bar and whiskers plots for grades. This summary analytics page also provides a table with per-student data for Page Views, Participations, Submissions, On Time, Late, Missing, and Current Score in the course. Aggregate reports (course level analytics, gradebook, etc.) for instructors of large courses have been reported as slow or non-responsive due to the time needed to load quantities of data involved.

Instructors can also access a student access report that shows Content, Times Viewed, Times Participated, and Last Viewed on a per student basis. There is also a student interactions report that shows the last interaction with the student, scores, and ungraded assignments; and Quiz Statistics, Test Item Analysis, Quiz Log Auditing reports.

7.9.3 Administrator/Researcher-Facing Analytics and Reporting

In addition to the above, Administrators can view all page views for a given user, which can be used for forensic purposes (e.g., whether a student actually accessed a given assignment). There are also a set of administrative reports (Course Storage, Grade Export, LTI Report, Last Enrollment Activity, Last User Access, Outcome Results, Provisioning, Public Courses, Recently Deleted Courses, SIS Export, Student Competency, Student Submissions, Students with no submissions, Unpublished Courses, Unused Courses, User Access Tokens, Zero Activity) that permit certain configuration data to be exported. It should be noted that these reports do not provide a full snapshot of the state of the system, as it was discovered during an outage that group affiliation and calendar time reservations are not recoverable here.

Separately a Canvas Data Portal provides access to detailed logs of activity in the system every 24 hours, with the last five days worth of logs available for access. For whole-term or cross-term analytics, these logs are aggregated daily in an institutional datastore provided by Unizin, the Unizin Data Warehouse.

To support actionable interventions by researchers, advisors, and teachers based on analysis of data emitted from Canvas, Instructure makes available a stream of click-based data that can be consumed in Amazon's Simple Queue Service (SQS) format; members of the University of Minnesota's Unizin

Learning Analytics evaluation team have successfully blended data from this Live Event Stream with information stored in the Unizin Data Warehouse to complete a proof-of-concept integration with CLA's APLUS advising system.

8   MOODLEROOMS/CANVAS ACCESSIBILITY COMPARISON

8.1   CANVAS ACCESSIBILITY

To minimize issues with accessibility, Canvas was developed using modern HTML and CSS technologies. Instructure is committed to W3C's Web Accessibility Initiative and Section 508 guidelines.

Instructure also provides a Canvas VPAT (Voluntary Accessibility Template) as a tool decision-makers may use to evaluate Canvas' conformance with the accessibility standards under Section 508 of the Rehabilitation Act and the Act WCAG 2.0 AA Standards.[59]

According to Instructure, they ensure that all new features are accessible prior to deployment to production environments. In addition, their Accessibility Team regularly retains independent accessibility firms and collaborates with end users to review and continuously improve Canvas. Their internal processes, external audits and the collaborative feedback from our all combine to help meet their commitments to accessibility.

Of note:

> "WebAIM.org, a third party authority in web accessibility, has evaluated the Canvas Learning Management System (LMS) by Instructure and certifies it to be substantially conformant with Level A and Level AA of the Web Content Accessibility Guidelines version 2.0. A representative sample of system views was evaluated for accessibility. This sample included course pages, calendars, quizzes, and communication tools."[60]

A Canvas Accessibility Testing & Evaluation (CATE) was undertaken by members of the Access Technology Higher Education Network (ATHEN) and published in April 2016. They noted that Instructure has a "very proactive accessibility team" that had already approached them about their results, and had possibly already fixed some. They also noted that the Agile development methodology that Instructure uses for Canvas enables them to fix problems quickly.[61]

8.2   MOODLEROOMS ACCESSIBILITY

Blackboard, the company that owns MoodleRooms, designs and develops all products in accordance with Web Content Accessibility (WCAG) Guidelines 2.0 Level AA as well as the Section 508 standards in the U.S. A third party "conducts regular audits" of their software.[62]

[59] https://community.canvaslms.com/docs/DOC-2061
[60] https://community.canvaslms.com/docs/DOC-2061
[61] Canvas: Accessibility & Testing Evaluation CSUN 2016, https://dl.dropboxusercontent.com/u/3486333/presentations/2016/csun2016/CATE_CSUN_2016.pptx?dl=1
[62] "Accessibility": https://en-us.help.blackboard.com/Moodlerooms/Administrator/Accessibility

MoodleRooms complies with ADA, XHTML and JavaScript standards for accessibility and Web browser compatibility. Standard accessibility tests are available on every page.

Blackboard provides for MoodleRooms a MoodleRooms VPAT (Voluntary Accessibility Template) as a tool decision-makers may use to evaluate Canvas' conformance with the accessibility standards under Section 508 of the Rehabilitation Act and the Act WCAG 2.0 AA Standards.

ATHEN has a Moodle Accessibility Collaboration group with members from a variety of colleges and universities. The group finds and monitors accessibility issues, then works with Moodle HQ to get them addressed.[63]

9   CANVAS/MOODLEROOMS PRODUCT ROADMAPS

A product technology "roadmap" is a plan that "matches short-term and long-term goals with specific technology solutions to help meet those goals. It is a plan that applies to a new product or process, or to an emerging technology."[64]

The information that both companies provided sets general direction for upcoming quarters. We were asked not to share specific timelines or enhancement specifics, since unforeseen circumstances may always impact implementation.[65]

9.1   BLACKBOARD'S MOODLEROOMS ROADMAP

In development, MoodleRooms has: performance improvements, *Collaborate*[66] improvements, and new Moodle 3.2 features.

In design, they have *Google Apps for Education* integration, course meta data, and *Ally* for instructors and students. *Ally* is intended to evaluate and teach users how to update course content to make it more accessible.[67]

In the planning stage, are new personalization options, grading workflow improvements, site wide automation and personalization, and a plugin for *SafeAssign*, a plagiarism-checking application.

9.2   INSTRUCTURE'S CANVAS ROADMAP

Canvas's 2016 final quarter roadmap included enhancements to their *Office 365* and *Google Apps for Education* integrations, the introduction of Mastery Paths, Mobile Student annotation, easier feedback for CanvasDocs and Gradebook, and more timely Canvas data provision.[68]

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[63] http://collaborate.athenpro.org/group/moodle/

[64] Wikipedia, https://en.wikipedia.org/wiki/Technology_roadmap .

[65] Specifically, statements regarding these Product development initiatives, including new products and future product upgrades, updates or enhancements represent MoodleRooms' current intentions, but may be modified, delayed or abandoned without prior notice and there is no assurance that such offering, upgrades, iupdates or functionality will be come available unless and until they have been made generally available to customers.

[66] Refers to Blackboard Collaborate, Blackboard's web-based videoconferencing solution.

[67] "MoodleRooms: Open for All," http://elearningmagazine.co/2017/01/10/moodlerooms-open-for-all/ .

[68] Now that we are in the first quarter of 2017: Office365 and Google Apps enhancements are in public beta release (UMN faculty are testing); Mastery Paths is now available for general release. Others in this list are in advanced stages of testing and

Canvas's 2017 first quarter roadmap includes simpler administration for Master Courses, Enhancements in learning outcomes and Mastery Paths, and new quizzes.

10 Next Generation Digital Learning Environment (NGDLE)

Participation in the consortial effort of Unizin, coupled with the current LMS review, has become a catalyst for developing a vision for the future of teaching and learning at the University of Minnesota.

An influential framework for this future growth and flexibility is outlined in an article sponsored by EDUCAUSE and The Bill and Melinda Gates Foundation, called The Next Generation Digital Learning Environment (NGDLE).

A core principal of a NGDLE highlights a shift in focus from an LMS as the sole environment in which learning takes place, to being only one part of an "integrated and interconnected environment of tools." Through the use of standards that connect its different systems, this environment would provide a learner-centered, open, and interoperable platform able to support new models of learning, such as competency-based education (CBE) and personalized learning.

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have expected availability in 2017.

Figure 18 In an NGDLE, the LMS is only one of several systems that are connected in an integrated teaching and learning ecosystem.

10.1 POWER OF THE NGDLE

The power of an NGDLE lies in its openness and interoperability, allowing easier sharing and blending of data among systems, standardized connections between systems, and a Lego-like ability to "plug" and "unplug" connected tools, obviating the need for custom integration development and maintenance and making migration of content easy. These enable the institution to retain ownership of its own data and intellectual property (as opposed to vendor ownership) and provides easier means for extending access to the wider community and promoting collaboration across the University and beyond.

The authors state, "These [NGDLE] environments are critical for using technology to affordably scale and improve education" (*Next-Generation Digital Learning Environments: Closer Than You Think!* , EUNIS 2016).

10.2 FUNCTIONAL DOMAINS OF THE NGDLE[69]

The principal functional domains of the NGDLE are interoperability; personalization; analytics, advising, and learning assessment; collaboration; and accessibility and universal design.

10.2.1 Interoperability: "the lynchpin of the NGDLE"

Interoperability in the NGDLE context refers to:

- Components accepting and sending curricular content in common formats and using standard backing data elements.
- Tool integration must be easy and allow end users to quickly add tools to the environment, without central IT being involved.
- The learning environment continues to be the "key source of learning data. The unimpeded exchange of data is imperative to be able to aggregate, integrate, and analyze learning data." (NGDLE, p. 4).
- "The NGDLE must enable the creation of new interoperability standards in ways that are compatible with its other standards so that overall coherence is maintained." (NGDLE, p. 4).

10.2.2 Personalization

Interoperability is necessary for personalization and personalized learning. Interoperable standards are invisible to the user, but they are what allow the user to easily create a customized environment. "A learning ecosystem that enables learners and instructors to act as the architects of their environments is a powerful tool." (NGDLE, p. 5).

Two important aspects of this are first, the "configuration of the learning environment, which is then used to construct pathways to accomplish learning tasks and attain learning goals." This supportive configuration must be done through all levels – "departmental, divisional, institutional, and consortium." The second aspect concerns adaptive learning, an area currently being explored by textbook publishers and learning content producers. To be effective, adaptive learning systems require robust data provided through learning analytics tools (NGDLE, p. 5).

10.2.3 Analytics, Advising and Learning Assessment

In the context of the NGDLE, there are two dimensions to this functional domain: learning analytics[70], and integrated planning and advising systems (IPAS).

Currently, learning analytics exists within the propriety boundaries of LMS platforms (NGDLE, p. 6). A

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[69] It bears repeating that the information in this report on the NGDLE leans heavily on the original article published through EDUCAUSE and The Bill and Melinda Gates Foundation, called The Next Generation Digital Learning Environment: A Report on Research.

[70] Defined as "the measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs." (From NGDLE, p. 11; 1st International Conference on Learning Analytics and Knowledge 2011, Banff, Alberta, Canada, February 27–March 1, 2011.

NGDLE would maintain learning analytics functionality outside of the LMS, available and owned by the institution, and able to integrate data from a large variety of tools.   This would only be possible through interoperable standards between these tools and the data that is being merged.

10.2.4 Collaboration

The NGDLE calls the traditional LMS a "walled garden" – designed around the course and the LMS environment that is limited to enrolled students. Social networking is one force that has changed the expectations of learners and provided pressure to the idea that an open system is necessary for the multiplicity of learning collaboration forms digital technology provides.

In order to be effective, the NGDLE posits that "support for collaboration must be a lead design goal, not an afterthought."

> *The current LMS is often designed on the transmission model of education—a mechanism to transmit syllabi, content, and assessments. This process is important for the management of the course, but equal time must be given to collaboration, a true learning dimension. The NGDLE must provide learners with individual spaces that persist across entire academic careers (and possibly into professional lives), serving as a base for all learning operations. Tools such as portfolios and tools for content creation must also be fully integrated into the environment. (The NGDLE, p. 7)*

10.2.5 Accessibility

As with the functional domain of collaboration, above, a learning ecosystem that supports accessibility must be designed from its foundation with a universal design approach to support the needs of all instructors and students.

> *The confederated approach we propose for the NGDLE is the key to progress in accessibility and universal design. This approach would encourage the development of specialty tools that could potentially address the more difficult obstacles to accessibility. Embracing interoperability standards would enable faster, more effective integration of these tools into the larger learning environment, and including accessibility standards as part of interoperability will help produce components that support people with disabilities. Similarly, including accessibility in personalization and adaptive learning support helps balance the need for universal design of the learning environment with the opportunity to provide individually tailored experiences that are sensitive to accessibility requirements. (The NGDLE, p. 8)*

As the authors point out, no single application can provide the requirements of all of these domains. That is why they recommend a "Lego" approach, where components all conform to NGDLE specifications. This would allow institutions and individuals to "construct learning environments tailed to their requirements and goals." *(The NGDLE, p. 1)*

10.3 NGDLE Functional Domains Support in a Learning Ecosystem

As repeated in a second white paper, *Next-Generation Digital Learning Environments: Closer Than You Think!* [71] the original NGDLE report, "Interoperability is the lynchpin of the NGDLE. " Several of the

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[71] *Next-Generation Digital Learning Environments: Closer Than You Think!* , EUNIS 2016.

enabling standards for interoperability have been developed by IMS.[72]

Simply put, selecting systems, applications and data that use interoperable standards can be more easily connected and can more easily share data, allowing for the benefits in the areas below.

1. **Support for learning content standards and universal design** would be achieved through:
    - Open, interoperable course and content archiving and integration standards (IMSCC, LTI, QTI, ePub, Caliper, etc.)
    - Suite of scaffolds for effective design (e.g., UDOIT universal design validator/recommender system)
    - Ease of use for instructors, students
    - Appropriate exchange of data with integrated tools

2. **Support for Customization** refers to the ability to adapt the learning platform to address the unique needs of particular courses, programs, or learning contexts. Examples include:
    - App store/EduAppCenter
    - Manage themes and course templates at the department/program level
    - Set outcomes, define rubrics, mastery paths, etc. at the program level

3. **Support for Personalization** manifests as:
    - Easy integration with learners' (and instructors') preferred productivity tools (e.g., Google apps) and devices (mobile apps)
    - Support for individual learner analytics (e.g., via Unizin *Course Monitor* aka *Snapshot)*
    - Support for adaptive learning via mastery paths

4. **Aggregating & Connecting data:**
    - Appropriate exchange of data among learning tools facilitates the blending and reporting of global learning analytics (e.g., Unizin Data Warehouse, Unizin *Course Monitor* aka *Snapshot*, *APLUS*, UMN's advising system).
    - Open content and tools standards enable the easy sharing of learning content and outcomes with peers and the world (Commons, Portfolio)

5. **Mash-Up Architecture** is provided through interoperable standards and easier data sharing.
    - Unizin *Course Monitor* aka *Snapshot* and the Unizin Data Warehouse provide open architectures for combining learning data from multiple sources and generating/ sharing views with instructors and students
    - Canvas page and module authoring tools facilitate the combination of content and tools from multiple sources in a common experience

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[72] "IMS was founded in 1995, as a project within the National Learning Infrastructure Initiative of EDUCOM (now EDUCAUSE). In 1999, IMS became an independent organization with a mission to advance technology that can affordably scale and improve education participation and attainment. IMS now has 350 members (55 from higher education) that participate in activities around standards creation, innovative use of technology, and large-scale deployment to achieve learning impact. IMS has four major efforts that align closely with the NGDLE, these include: accessibility – the IMS standard Access for All6 ; analytics – the IMS Caliper Analytics standard7 ; interoperability – the IMS LTI2 standard8 ; and collaboration and personalization – the IMS Community App Sharing Architecture (CASA) project." (*Next-Generation Digital Learning Environments: Closer Than You Think!*, EUNIS 2016.

10.4 NGDLE FRAMEWORK: CANVAS/MOODLE COMPARISON

As part of the LMS review and evaluation, both Moodle and Canvas were assessed within the framework of the NGDLE; a finely detailed explanation for each score given, with examples from each LMS, is available as Appendix A in Canvas Technical Evaluation (Fall 2016 Final), pp. 25-41.

A summary follows the table below.

10.5 *Next Generation Digital Learning Environment (NGDLE) Functions Report Card*		
	Moodle	**Canvas**
10.5.1 Interoperability and Integration		
Support for standards	✓	✓ +
Ease of use	✓	✓ +
Ability to aggregate, integrate, analyze data	✓ -	✓
Ability to extend standards without losing integrity of existing data	✓ -	✓ +
10.5.2 Personalization and Customization		
Flexibility to adapt or extend platform to address individual teaching styles and disciplinary needs	✓	✓ +
Self-paced learning / competency mastery pathways	✓ +	✓ +
10.5.3 Analytics, Advising, and Learning Analytics		
Widening the scope of data	✓ +	✓ +
Platform, tool, and data integration	✓	✓ +
Learning analytics for all stakeholders	✓	✓
Integrated planning and advising systems	✓	✓
10.5.4 Collaboration		
Easy toggling between public/private course content and functions	✓ +	✓ +
Support for collaborative learning	✓ +	✓

Support for collaborative course development		✓	✓ +
Support for collaborative content development		✓ -	✓ +
10.5.5 Accessibility and Universal Design			
Accessibility is addressed in initial course/content design		✓	✓
Overall		✓	✓ +

10.6 COMMENTARY

The original EduCause review article does not weight or otherwise differentiate among the functions constituting the NGDLE.

For the purposes of this decision, however, it is possible to further contrast tactical NGDLE functions—i.e., those that primarily affect teaching and learning at the individual, course, and program levels (e.g., "Personalization and Customization" and "Collaboration")—with higher order strategic functions, particularly:

1. those that affect overall system usability (e.g., "Accessibility and Universal Design"),
2. the University's ability to get data *out* of the learning management system and blend those values with input from other sources to drive support interventions and strategic decision-making (e.g., "Analytics, Advising, and Learning Analytics"), and
3. the academic technology community's ability to assemble, extend, and innovate our institutional teaching and learning ecosystem (e.g., "Interoperability and Integration").

In short, the value of the ability to support collaborative learning or to customize the learning platform in the short term is diminished if --

1. the design of those customizations or collaborative learning functions make it more difficult to change or extend the learning platform in the long run, or
2. to extract data related to those customizations or learning activities and blend them with data from other systems, etc.

When we concentrate on those strategic categories, we find that:

- Moodle/Moodlerooms and Canvas/Unizin compare roughly equally in the area of accessibility, and
- Canvas/Unizin has a slight edge in the area of Analytics, Advising, and Learning Analytics.

Where we see the starkest difference is in the key category of Interoperability and Integration. The Canvas/Unizin adherence to common data standards and effective interface design improves the overall usability of the LMS toolkit for learners and instructors and greatly enhances the institution's ability to extend the learning platform, blend data, and customize reporting. Strength in this category provides a strong advantage for the Canvas/Unizin solution and paves the way for success in all other areas of NGDLE functionality over the lifecycle of the Canvas/Unizin solution.

Although the overall scoring appears close, if we were using a traditional grading scale (where

✓ - aligns with a 'D/F';

✓ aligns with a 'C' [meets expectations]; and

✓ + aligns with 'B/A'),

Then the Canvas/Unizin combined score would be a B/A (with no ratings below a C) and Moodle/Moodlerooms would be a C (with several ratings that come in below our expectations in an NGDLE platform).

When we concentrate on the key category of Interoperability and Integration, the Canvas/Unizin solution scores a strong B/A—with future plans from Unizin that promise to improve our ability to aggregate, integrate, and analyze data in the Unizin Data Warehouse—in precisely the category where Moodle/Moodlerooms struggle most, scoring below a C owing to issues with getting data out of Moodle (all of our current integrations—e.g., with both APlus and Rochester's iSEAL—require custom coded web service interfaces. Tools like Moodlerooms' *X-Ray* dashboards don't utilize interoperable standards, so our ability to blend Moodle data with information from other sources would be challenged).

In short, although the Moodle/Moodlerooms solution offers some of the functionality associated with the next generation digital learning environment concept, the design philosophy behind Moodle/Moodlerooms too often relies on proprietary data standards. In addition, the nature of community-led development in the Moodle community has led, in some instances, to redundancy of function and inconsistency of user experience in some Moodle modules.

Given these concerns, there is greater confidence in the extensibility, openness, and sustainability of the Canvas/Unizin solution as a system that satisfies both the letter and the spirit of the NGDLE design.

11 UMN AND THE UNIZIN CONSORTIUM

11.1 BACKGROUND

In 2014, the Provost's office, the Office of Information Technology, and University Libraries sponsored the University of Minnesota's membership in the Unizin consortium. The decision to join was a strategic investment to help prepare the University for the future of digital learning. As part owners of Unizin, UMN works with other leading research institution consortium members to direct the future of education, teaching technology, and learning analytics with the goals of improving access, affordability, and learner success.

The members of the Unizin consortium are:

Colorado State University   Indiana University
University of Michigan   University of Florida
University of Wisconsin-Madison   Oregon State University
University of Minnesota   University of Iowa

11.2 Unizin Goals

The goals that unite the member institutions under Unizin are to:

- Help direct the future of digital education, teaching technology, learning analytics and advising,
- Create the learning ecosystem of the 21st century,
- Keep control of our intellectual property and data, and
- Save money for institutions and, ultimately, students.

The three areas of focus for Unizin are 1) digital content, from creation, to curation, discovery, collaboration, and sharing; 2) learning platform to deliver content, with the requisite extensibility to support a 'plug-in' architecture, easily customizable by member institutions, and 3) learning analytics. "Through its strategic initiatives, institutions of higher ed will design and "own" their entire digital learning landscape. This means university-owned and operated content, applications, and data will become part of the Unizin ecosystem."[73]

Unizin staff (hereafter, Unizin Ltd.) that work for the consortium are under the direction of CEO Amin Qazi; developers, administrators and support staff at Unizin Ltd. manage the business of hosting open-source software, broker contracts between the Unizin consortium and commercial vendors as directed by the board, and design and develop new applications as well as integrations for Canvas, Unizin's chosen LMS platform.

11.3 Consortium Benefits

As a founding member of the Unizin consortium, UMN has representation on the Unizin board of directors (BOD), and so provides input to the priorities and projects of Unizin.   As a member institution of Unizin, the University of Minnesota directly influences Unizin's development of applications and services that will fit the University's needs, and leverages consortial knowledge and efforts in piloting and improving Unizin applications and services.

Some examples of how this works in practice:

- At quarterly meetings of the Unizin BOD, Unizin Ltd. staff receive direction from BOD members on product roadmaps.

- A Teaching & Learning group, composed of a variety of participants from each member university, meets quarterly as a group with Unizin Ltd. staff. They have helped forge ideas on technical issues, helped launch a Unizin learning analytics community of practice, and most recently, formed a collaborative project to facilitate faculty creation of free, shareable question databases for basic discipline areas for the use of all member institutions (to pair with open education resources).

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[73] "5 Questions about Unizin for Instructure,"
https://www.insidehighered.com/blogs/technology-and-learning/5-questions-about-unizin-instructure

- All but one of the Unizin member institutions is using their individual Unizin data warehouses to store learning analytics data from the Canvas LMS. Some institutions have more developed expertise in learning analytics and data warehousing, and other institutions have put their staff into contact with counterparts at the more advanced institutions to jumpstart efforts at their ow.

- Unizin Ltd. currently has seven applications in stages of development, testing and production. (More on these in section 11.4 below.) Unizin receives guidance from sponsor teams at member institutions in development, evaluation and "beta" testing stages. Sponsor teams meet with Unizin developers to discuss their feedback, which is incorporated into future development. Sponsor teams who undertake pilots at their own institutions can benefit from the experiences of those who have already piloted at other institutions (sharing help documentation, templates, and best practices they developed).

These are only a few examples of how the member institutions have been able to collaborate, support their mutual interests and goals, and directly influence the development of applications and services that will fit the needs of their institutions.

11.4 STATUS OF UNIZIN PRODUCTS AND SERVICES

The dashboard in Fig. 19 on the next page displays the stages of adoption of each of Unizin's member institutions for its current products and services.

The current annual membership cost for Unizin founding members is $427,500.00.[74] **All Unizin tools and services come free with Unizin membership, with the current exception of edX**, a new collaboration that offers a MOOC platform. A few interested members are undertaking to pay for all staff and costs devoted to its implementation by Unizin.

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[74] See section 13 for an analysis and comparison of what these tools would cost when purchased from outside vendors.

Figure 19 Unizin Consortium Member Dashboard

Institution	Canvas	Course Monitor (Beta)	Design Tool Hosting (GA)	Engage (GA)	Open edX Hosting (PoC)	Course Development Suite (Beta)	Pressbooks Hosting (GA)	ARQS (Alpha)	Unizin Data Warehouse (GA)
Colorado State University	Production 100 Percent	Pilot		Production 1,575 Sections/Year			Pilot	Pilot 600,000 Events/Day	Production 223 GB
Indiana University	Production 100 Percent	Pilot		Pilot 8 Sections/Year		Eval	Production 5 Public Books	Pilot 4,900,000 Events/Day	Production 784 GB
Ohio State University	Production 70 Percent	Pilot							Production 75 GB
Oregon State University	Production 100 Percent	Pilot	Production						
Pennsylvania State University	Production 75 Percent	Eval		Eval		Eval	Production 2 Public Books		Production 234 GB
University of Florida	Production 100 Percent	Pilot	Production	Pilot 1 Sections/Year			Pilot	Pilot 3,000,000 Events/Day	Production 92 GB
University of Iowa	Production 90 Percent	Pilot				Eval		Pilot 600,000 Events/Day	Production 552 GB
University of Michigan	Production 100 Percent	Pilot	Production	Pilot 12 Sections/Year		Eval	Production 0 Public Books	Pilot 1,500,000 Events/Day	Production 202 GB
University of Minnesota	Pilot	Pilot						Pilot 30,000 Events/Day	Production 9 GB
University of Nebraska-Lincoln	Production 30 Percent	Pilot				Eval	Production 3 Public Books		Production 11 GB
University of Wisconsin-Madison	Production 50 Percent	Pilot							Production 38 GB
Florida A & M University									
Florida Atlantic University			Production						
Florida Gulf Coast University									
Florida International University			Production						
Florida Polytechnic University									
Florida State University									
New College of Florida				Eval					
University of Central Florida		Pilot	Production	Production 4,793 Sections/Year				Pilot 3,500,000 Events/Day	Production 880 GB
University of North Florida			Production						
University of South Florida									
University of West Florida			Production						
Berkeley College									
Boise State University				Production 24 Sections/Year					
SAE Institute				Production 8 Sections/Year					

Nearly all member institutions share keen interest in *Course Monitor (*previously*, Snapshot)*, the student data dashboard that works inside of Canvas, as well as the Unizin Data Warehouse, where Canvas student performance data is housed. These both testify to the importance UMN and its peer institutions see in the development of learning analytics. Another striking feature of the dashboard is that **the University of Minnesota is the only member of Unizin that has not chosen Canvas for its centrally-supported LMS.**[75]

11.4.1 Canvas as Unizin's Chosen LMS

Canvas was chosen as Unizin's LMS in 2014. The choice was "based on a vision that universities need an open, cloud-scale platform to enable content sharing and better analytics to support all forms of digital education," according to Brad Wheeler, vice president for Information Technology and chief information officer at [Unizin member] Indiana University.[76] Canvas is built using the standards of interoperability described in the NGDLE, which provides the open and flexible platform that fits the needs of Unizin member institutions who want to build and own their learning ecosystems.

UMN's Unizin Pilots

UMN has been involved in six Unizin pilots/initiatives:

1. Unizin OER (Open Education Resource) Authoring Task Force Report and Pressbooks (open resource publishing platform), University Libraries.

2. *Engage* digital content platform, led by University Libraries. Now in its third semester of a pilot.

3. *Course Development Suite*, led by University Libraries. Just finished alpha development, beginning evaluation.

As assessment of the projects above is made in the Unizin Content Report .

4. *Course Monit*or data dashboard, formerly known as *Snapshot,* led by Academic Technology-OIT. Now in its second semester.

A description of the first semester of the *Course Monitor [aka Snapshot*] pilot is in the UMN Unizin Course Monitor Report.

5. Unizin Data Warehouse, led by OIT. In pilot production and receiving student performance data from the Canvas LMS. A proof-of-concept project in process, combining data from Canvas, PeopleSoft, and Aplus advising system to create a "common data layer" upon which to conduct analysis for decision-making and reporting.[77]

6. UMN staff and faculty participate in a Unizin Learning Analytics Community of Practice that

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[75] The University of Florida System recently chose Canvas as its centrally-supported LMS.
[76] "Unizin, a New Higher Ed Consortium, Chooses Canvas as its Platform," http://www.prnewswire.com/news-releases/unizin-a-new-higher-ed-consortium-chooses-canvas-by-instructure-as-its-foundational-learning-platform-262692421.html
[77] The final report for the UMN learning analytics project will be issued in April 2017.

meets monthly. In March 2017, the Center for Educational Innovation begins a UMN Learning Analytics Faculty Community of Practice, co-hosted with UMN learning analytics researcher and faculty member Bodong Chen (CEHD).

It is important to note that some tools are further along than others, and in some areas, Unizin still has to prove its worth. As the Unizin Content Report notes, for example,

> *While content services are important to Unizin, Unizin's development staff have been focused more on learning analytics tool development (Snapshot [aka Course Monitor] and other tools) over the past two years. Unizin's plans for content development support hold a great deal of potential, however currently the major tools they have developed or planned in this space, especially the Course Development Suite, are limited and are rudimentary and yet to offer sufficient value.*

The progress made by Unizin Ltd. in the past six months on Course Monitor and the Data Warehouse, however, as as well as the fruitful collaborations among the Unizin consortium members, point to the high potential of future development and collaboration. The Unizin Content Report continues,

> *Despite observations of shortcomings with many of the content related tools, we do believe that participation in Unizin provides the University the opportunity to be at the table and provide a direct voice into the future development of these very nascent tools   Although we cannot predict the direction Unizin content tools will take in the future, we believe that removing our institutional voice from this process at this point in time would be detrimental to our faculty and students in the long run.*

Unizin's success in reaching its potential, for the benefit of all members, will depend on the commitment of each of its member institutions.

12 UNIZIN ROADMAPS

The following section provides Unizin's descriptions and roadmaps for their current (and planned) tools and services.

12.1 UNIZIN ENGAGE

(formerly Courseload Engage)
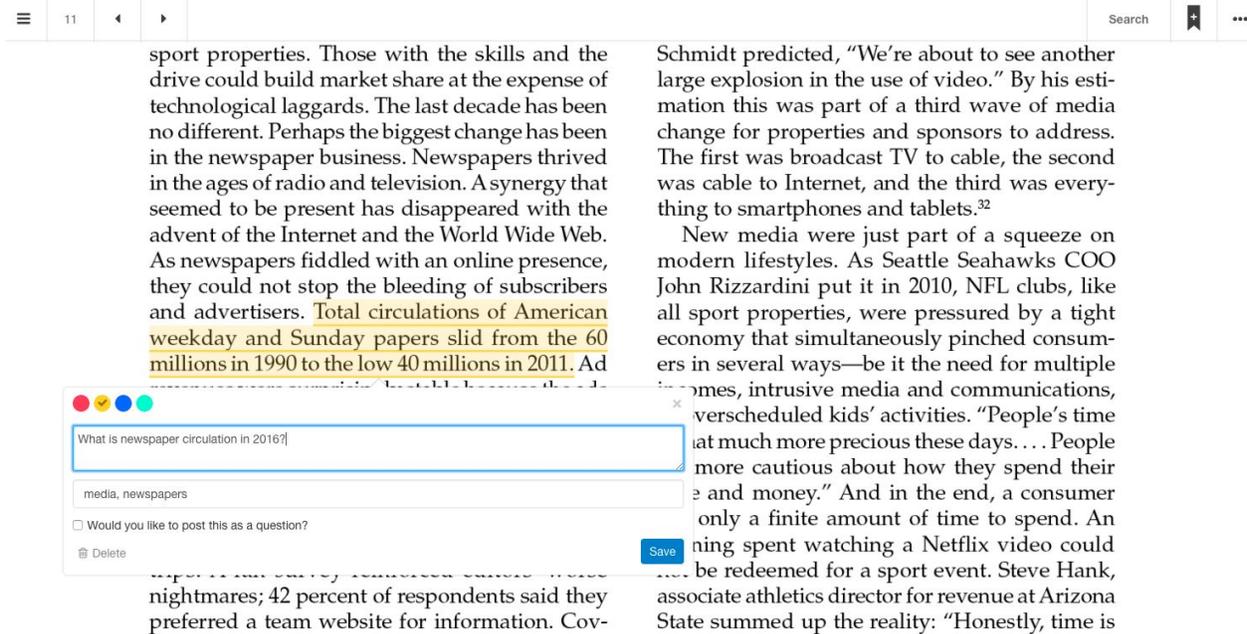
Figure 20 Screenshot of Unizin Engage, with annotation and note

Status: Available

Short Description: Platform to read eTexts

Long Description: The Unizin Engage e-reading platform, which integrates with the Canvas learning management system, provides access to course materials via any device. Additional features include:
- Immediate availability of all course materials
- Access to all eTexts for the duration of a student's enrollment
- On-demand printing options
- Real-time learner analytics
- Contextual guidance from instructors delivered through annotations
- Collaborative tools that turn passive reading into an active process
- Online and offline viewing options

Technical Description: Engage is an LTI Provider and can be launched from any LTI-compliant Consumer (usually LMS).

Goals/use case: when students have access to affordable textbooks on the first day of class, they are more likely to be prepared and succeed. Secondly, faculty access to in-text question and answer features and page-read analytics can help instructors identify students struggling with concepts and intervene, if necessary.

Audience: Faculty and students

Advantages:
- Publisher services and OER compatibility create conditions for more affordable course content

- Access to all course materials on the first day and for length of enrollment
- Student-student collaboration through a common platform and toolset
- Increased student-faculty engagement through content-based Q&A
- Faculty choice is preserved, regardless of source (publisher, OER, self-generated) or type (video, text, audio, etc.)
- Course-wide analytics can facilitate interventions and guide course improvements
- Offline functionality

12.2 UNIZIN DASHBOARD TOOL (COURSE MONITOR)

(formerly Snapshot)

Status: Testing (Pilots and Evaluations)

Short Description: Section-level dashboard of the Canvas Gradebook; includes a model for faculty/student engagement in the course.

Long Description: An initial version of a new Canvas-integrated dashboard tool for examining student performance in a course, allows instructors to see students' performance compared to their peers on quizzes, assignments, overall engagement, and current grades, all directly within Canvas. Snapshot also enables educators to drill down and look at an individual student's performance over time in their course.

Technical Description: The Unizin dashboard tool is an LTI Provider and can be launched from any LTI-compliant Consumer (usually LMS).

Goals/use case: the ability to integrate disparate data sources easily gives institutions the ability to personalize their dashboards to meet their teaching and learning needs.

Audience: Faculty, students (if desired), and eventually advisors

Advantages:
- Quickly identify at-risk students
- Personalize learning and interventions with insights into grades and submissions
- Transparent data models
- Opportunities for cross-institutional collaboration on identifying new data sources and improving insights
- Customizable for local learning analytics communities
- Integrated with the learning management system
- Student cards and other visualizations make for simple usability
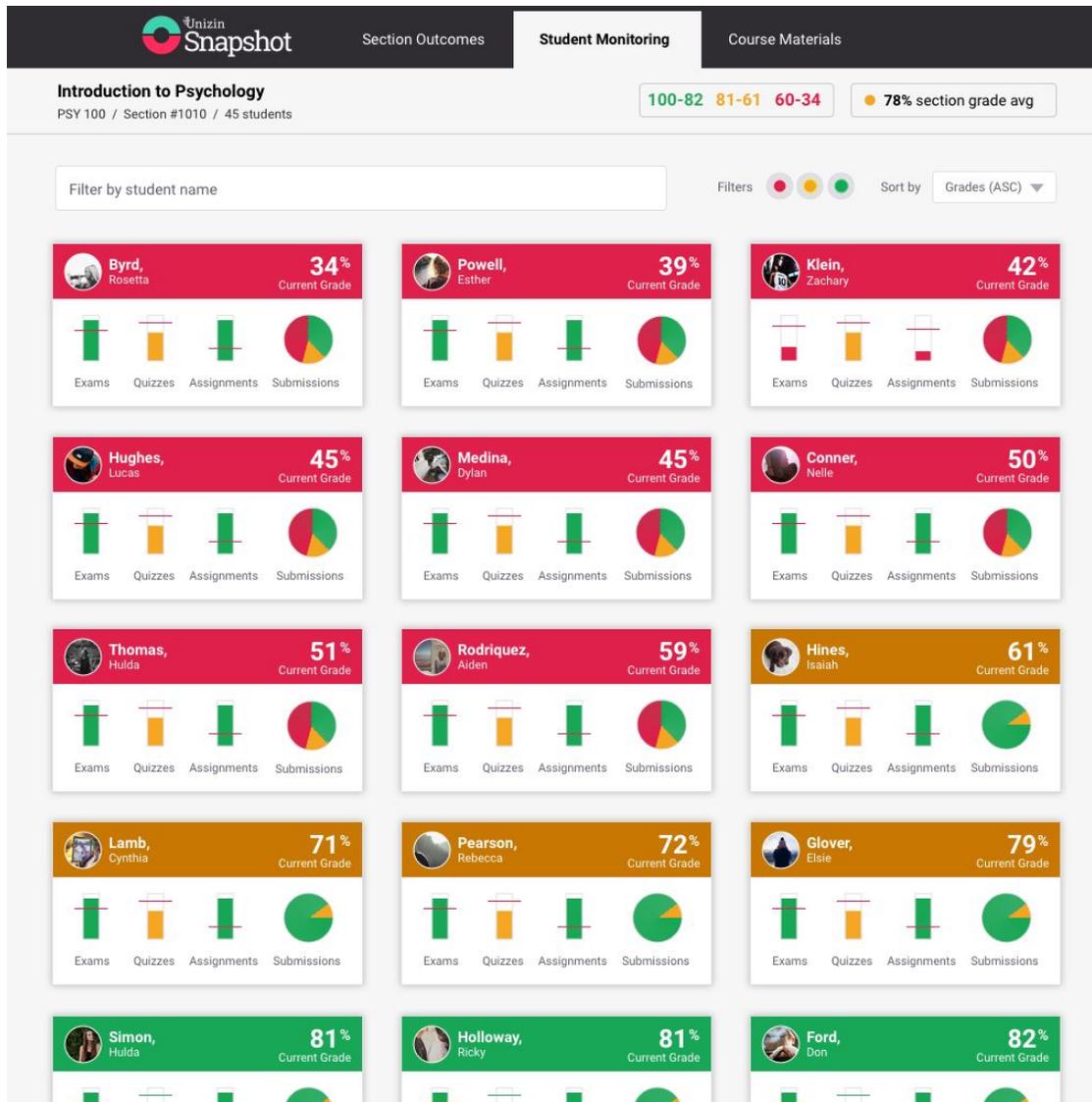
Figure 21 Screenshot of Course Monitor aka Snapshot

12.3 UNIZIN DATA WAREHOUSE

Status: Available

Short Description: General-purpose data warehouse solution

Long Description: The Unizin Data Warehouse (UDW) is a place where Unizin institutions can store, analyze, and use data from the learning environment. It enables access across a single institution in order to provide a unified portrait of learner, course, and interaction data. The UDW is positioned to consume third-party teaching and learning vendor data and make it quickly available for consumption by Unizin institutions via Amazon services.

Technical Description: The UDW is built using Amazon Redshift.
- Front End: None
- Back End: Python/Django app (Canvas Data Mover)
- Core Technologies:
  - o AWS Redshift - individual database for each member
  - o PostgreSQL - storage of configuration data only
- Deployment: AWS using EC2, S3 (encrypted buckets), Canvas Data API (over HTTPS), Redshift cluster
- Monitoring: New Relic

Goals/use case: a uniform data warehouse is the first step in driving consistent data management practices across the Consortium. It can help reduce local efforts and set the foundation for aggregated data to empower research.

Users: IT, faculty, researchers - intended for institutional use and research

Advantages:
- Reliable and timely data transfers
- Efficient data storage
- Lays the foundation for cross-institutional collaboration with consistent data management practices
- Governed by local data policies

12.4 PRESSBOOKS HOSTING

Status: Available

Short Description: Cloud-based tool to create eTexts

Long Description: Pressbooks is easy-to-use book writing software that lets you create a book in all the formats you need to publish. Pressbooks delivers print-ready files as well as ebook files. Export formats include PDF, ePub, MOBI, XML, XHTML, and others.

Users: Faculty, staff, various institutional authors

Advantages:
- Ability to publish in a variety of formats
- Free to Unizin Members
- Streamline publishing operations
- Produce course texts rapidly
- Create open textbooks
- Hosted on a central, WordPress-based platform
- Produce additional publications such as scholarly monographs, gray publishing, and more

12.5 COURSE DEVELOPMENT SUITE

(formerly Content Studio)

Short Description: Suite of three applications designed to manage educational content

12.5.1 Collections
(formerly LaunchPad)

Status: Testing (Evaluations and Betas)

Short Description: Application for curating, publishing and sharing institutionally-authored content collections

Long Description: Collections enables a university's content producers to curate learning objects into themed collections. It allows these content producers to control and direct the use and discovery of their content collections. It captures valuable learning metadata and enables the grouping of content into thematic collections to make discovery efficient. For example, an organization might publish a collection of pictures and descriptions of local flora and fauna.

Users: IT, multimedia developers, instructional designers, librarians

Advantages:
- Content producers control and direct use of their content
- Captures rich learning metadata
- Themed collections enable efficient discovery

12.5.2 Discover
Status: In Development (target 2017 for deployment)

Short Description: Application for finding learning objects

Long Description: With Discover, instructors or course development teams can search their institution's content repository by course subject, discipline, or learning object type. They can then download the content or adopt it into Course Libraries to help develop a course.

Users: IT, instructional designers, librarians, faculty, teaching and learning staff

Advantages:
- Ability to search by course subject, discipline, or learning object type
- View versions
- View history of usage and owner

12.5.3 Course Libraries
(formerly *Libraries*)

Status: Design Phase (target 2017 for deployment)

Short Description: Application for assembling courses using content

Long Description: When instructors or course development teams have found content they want to use in a course, Course Libraries helps them organize it into weeks, modules, chapters or any other delineation they might find useful. Teams can chat in the application and request new content, if needed. An activity log tracks changes made by team members.

Users: Instructional designers, librarians, faculty, teaching and learning staff

Advantages:
- Structure courses with the help of a team, if desired
- Construct courses with content according to week, module, chapter, etc.
- Track changes made by team members with activity log
- Save unused course materials for later use
- Request changes to content, new learning objects, or accessible versions of content (ex: a video with captions) directly from the application

12.5.4 Open edX

Status: In Development (target 2017 for deployment)

Short Description: Unizin hosting and enhancements of open edX platform

Long Description: Open edX is the premier open source MOOC platform, used by leading global institutions. Open edX provides a path to hybrid learning for global & life-long learners where Unizin Members can control their brand. Open edX also is modular, allowing for targeted, incremental improvements in alignment with the Unizin mission when and where necessary.

Users: Instructional designers, faculty, teaching and learning staff

Advantages:
- White label Open edX instance
- Integration with Unizin tools, including Course Development Suite
- Track learner activity within the platform for normalization and aggregation within the Unizin Data Warehouse
- Access to differentiating tools such as blank advanced problem, circuit schematic builder, drag and drop, image map input (hot spot), math expression input, custom Python-evaluated input, problem in LaTex, and problem with adaptive hints

12.5.5 Research Services
Status: Discovery (target 2018 for deployment)

13 UMN's Future Learning Ecosystem

Based on trends in higher education technology and work done at UMN peer institutions, the tools

and services the Unizin consortium is developing will be needed, and expected, by UMN faculty and staff within the next 1-5 years. These are in the Unizin-focused areas of digital content creation, management and sharing (including open educational resources) and learning data analytics.[78]

Fig. 22 below compares the cost for supplying these tools for a learning ecosystem through Unizin to the cost of acquiring them for vendors. Notes are provided to explain estimates as needed. Staff costs are based on YTD OIT staff reporting.

By continuing down the path of partnership in the Unizin consortium, UMN's learning ecosystem will be able to grow, becoming the powerful platform our students and faculty need to move into the future.
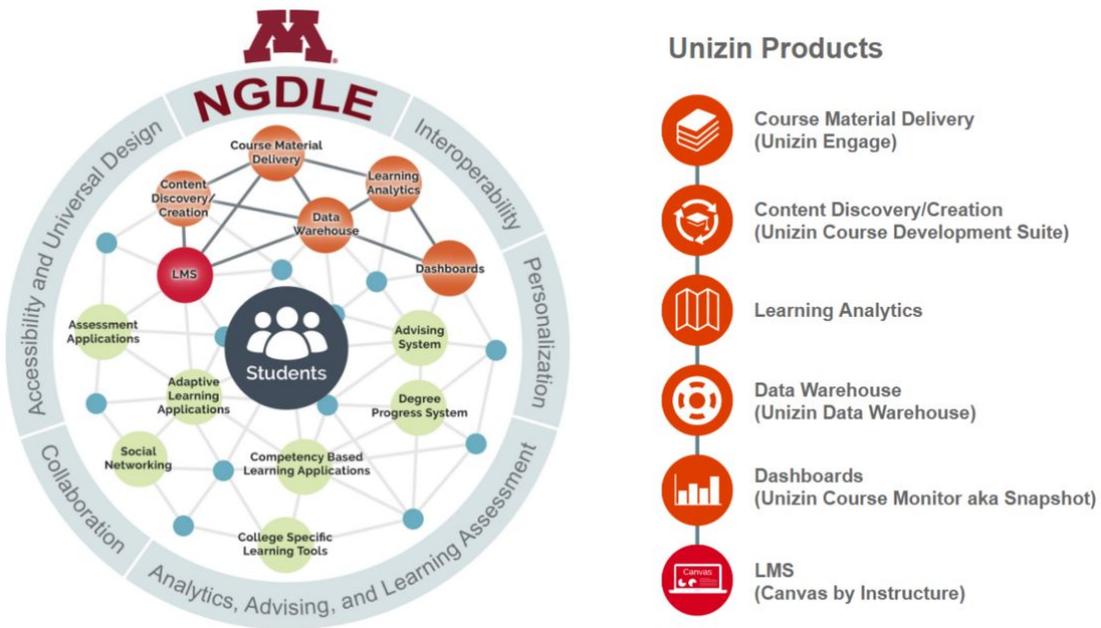

Figure 22 UMN's Projected Future Learning Ecosystem, with Unizin

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[78] In fact, there have been localized efforts in these areas, some quite successful, as in the work University Libraries has done with helping students save money using Open Educational Resources, UM-Rochester's research and use of Moodle student performance data in iSeal, and CLA's APlus advising system, which uses student data from Moodle to assist advisors in helping at-risk students. UMN's Office of Planning and Analysis also piloted EAB in 2015-16. There are currently no plans to follow up the EAB pilot with further implementation.

	Unizin	Projected Non-Unizin	
Consortium Fee	$427,500.00		
Course Management System			
Licensing Fees	$980,980.00		
			(Assumes onsite hosting; if SaaS, use
Infrastructure		$229,000.00	*MoodleRooms cost from section 5.2.4)*
Staff **	$502,135.00	$638,807.00	
Real Time Data Feed		$6,000.00[79]	
Content			
Repository		$300,000.00[80]	*(Annual Equella cost - low estimate)*
Discovery		$0.00	*(Included in Equella above)*
Authoring*		$15,000.00	*(UMN Libraries cost to host Pressbooks)*
Engage*		$75,000.00	
OER			
Analytics			
Dashboards		$462,000.00[81]	*Early-warning Dashboard*
Analytics Support Services	*$100,000.00*	$1,500,000.00[82]	*(Projected EAB fees)*
Unizin Data Warehouse			
Largest Learning Laboratory			
Total	$2,010,615.00	$3,225,807.00	

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[79] $500 a month + .25 of FTE Sys Admin (MoodleRooms or self-hosted)

[80] Equella is a digital content repository owned by Pearson, analogous to Unizin's Content Relay. This estimate is from U of Utah; they pay $175,000 (with 31,000 IPED student enrollment).

[81] Blue Canary provides a data dashboard; this estimate is based on their price for an institution the size of UMN. Interesting note: Unizin considers using Blue Canary instead of developing its own dashboard, but then Blackboard bought it.

[82] EAB is an enterprise-level student, data, and learning analytics application. It generally requires extensive consulting services from the vendor in order to customize it to institutional needs. This estimate is conservative and based on reports from peer institutions.

14 APPENDICES

14.1 REPORTS CITED IN THIS REPORT (WITH LINKS AND AUTHORS)

LMS Market Dynamics, Fall 2016 Edition. Provided by MindWires LLC. Subscription for UMN system staff and faculty. Unauthorized reproduction or sharing is strictly prohibited.

LMS Market Dynamics, Spring 2017 Edition. Provided by MindWires LLC. Subscription for UMN system staff and faculty. Unauthorized reproduction or sharing is strictly prohibited.

4th Annual LMS Data Update, EduTechnica, Fall 2016.

Infrastructure-OIT Moodle Assessment. Christian Dinger, Applications Architect, Mark Skweres, Data Architect, and Kemal Badur, Sr. Director, Infrastructure & Production, Office of Information Technology (OIT).

MoodleRooms SaaS presentation. February 2017. Jeff Weber, AT Tools Service Owner, OIT.

High Level Security Assessment of the Canvas and Moodle Learning Management Systems report. Derek Meier, Security Analyst, University Information Security, OIT. (The report is not linked here in order to prevent the introduction of additional risk. The analysis identified numerous security challenges with our existing Moodle environment. Those challenges relate to maintaining compliance with the University's Information Security Policy.)

Summary Report for Canvas Learning Management System Usability Evaluation (faculty) Nick Rosencrans, User Experience Analyst, OIT.

Summary Report for Canvas Student Experience Usability Evaluation (students), Nick Rosencrans, User Experience Analyst, OIT.

The Canvas Learning Management System: Instructor and Student Experience Final Evaluation January 2017. Paul Baepler, Researcher, Center for Educational Innovation.

Fall 2015 – Instructor and Student Canvas Pilot Evaluation. Paul Baepler, Researcher, Center for Educational Innovation.

Evaluation of the Instructor and Student Experience of the Pilot of the Canvas Learning Management System Spring, 2016. Paul Baepler, Researcher, Center for Educational Innovation.

Analysis of our onsite Moodle system's planned and unplanned outages. AT Tools team, OIT.

Canvas Technical Evaluation (Fall 2016 Public). Chris Scruton, business analyst, and Erik Epp, academic technologist, AT-OIT.

Canvas Technical Evaluation (2015-2016). Chris Scruton, business analyst, and Erik Epp, academic technologist, AT-OIT.

UMN Canvas Pilot 2015-16 Report. Donalee Attardo, Sr. Director of Academic Technology-OIT, Chris Scruton, business analyst, and Erik Epp, academic technologist, AT-OIT, Paul Baepler, Researcher,

Center for Educational Innovation.

UMN Unizin Course Monitor Report.   Lauren Marsh, academic technologist, Academic Technology Support Services, OIT.

Unizin Content Report. Kristi Jensen, Associate Librarian and e-learning coordinator, and Shane Nackerud, business analyst, Digital Library Development Lab, University Libraries.

14.2 MEMBERS OF ULTA, AY2016-17

Voting Members	

Representative	College
Lee-Ann Breuch (Chair)	CLA
Lisa Ahmann	Dentistry
Alyssa Bonnac	Continuing Education
Bruce Brorson	UMN Crookston
Michelle Driessen	CSE
Robert Dunbar	UMN Rochester
Robert Fecik	Pharmacy
Derek Frank	Undergraduate, Bio Science
Brian Gute	UMN Duluth
Kristi Jensen	Libraries
Kristin Lamberty	UM Morris
Peggy Martin	AHC

Krishona Martinson	UM Extension
William McGeveran	Law
Annika Moe	CBS
Rebecca Montgomery	CFANS
Lana Peterson	Graduate, CEHD
Austin Quam	Undergraduate, CLA
Margaret Root Kustritz	Vet Med
Dereck Salisbury	Nursing
Jodi Sandfort	Public Affairs
Daniela Sandler	Design
Soumya Sen	Carlson
Jill Trites	CEHD
Julian Wolfson	Public Health

Non-Voting Members	

Name	Role	Department
Ilene Alexander	Provost's representative	Center for Education Innovation
Donalee Attardo	OIT representative	Academic Technology - OIT

John Bothe	Communications support	OIT Administration
Erik Epp	Business analyst	Academic Technology - OIT
Sara Hurley	Academic administrative leadership	SPH
Amanda Rondeau	Academic technology representative	CEHD
Peg Sherven	Academic technology representative	AHC
Emily Stull Richardson	Secretary	CLA

14.3 CANVAS PILOT TEAM

The 2015-2017 Canvas pilot project team was composed of the following individuals:

Alex Anderson
Kara Hanson
Bruce Reeves
Annette McNamara
Kristin Riker-Coleman
Amanda Evans
Drew LaChapelle
Paul Baepler
Lauren Marsh
Keith Brown
Mark McKay
Donalee Attardo
Tony Leisen
Erik Epp
Kim Wilcox
Sara Schoen
Emily Stull Richardson
Chris Scruton
Jennifer Englund

Susan Tade
Melissa Falldin
Jeff Weber
John Bothe
Yelena Yan
Qi Zhang