To Build or to Buy, That is the Question

Dr. Wanju Huang, Purdue University

Dr. Wanju Huang is a Clinical Associate Professor of Learning Design and Technology at Purdue University. Her research interests focus on online learning, professional development in STEM, augmented reality/virtual reality, and the integration of artificial intelligence in education. She has contributed to three NSF-funded projects as co-PI and key personnel. Additionally, she has been a co-PI for grants funded by the Susan Harwood Training Grant Program of the Occupational Health and Safety Administration (OSHA) and Substance Abuse and Mental Health Services Administration (SAMHSA) under the U.S. Department of Health and Human Services. Currently, she is leading the professional learning evaluation for the Micro-Electronics Security Training (MEST) initiative, which is part of the Scalable Asymmetric Lifecycle Engagement (SCALE) funded by the Department of Defense.

Ms. Margaret Wu, Purdue University

Marge Wu is a Senior Research Analyst with the Micro-electronics Security Training (MEST) Initiative. She has a decade's worth of diverse experiences working in assessment, instructional technology support and development, and information technology units in higher education. Her professional interests include the intersection of technology and pedagogy, online learning, outcomes and program evaluation, and survey methodology. She holds a M. S. Ed in Literacy and Language Education and a BA in English Secondary Education, both from Purdue University.

To Build or to Buy, That is the Question

To Build or to Buy: That is the Question

Introduction

Sabharwal and colleagues [1] defined Learning Management Systems (LMSs) as "a vital software platform to deliver education and training courses online. They enable the creation, management, and delivery of educational content making it easier for business of all sizes and types to administer educational content" [1]. With the versatility of LMSs, LMSs have become perhaps the most ubiquitous instructional technology across all modalities and levels of education. Due to its ubiquity, the market for the technology is mature, with 4-5 dominant competitors (e.g., Blackboard, Canvas, Brightspace, Moodle, Google Classroom) depending on the level of learners in question and dozens of options beyond the dominant vendors available. Although there are many options on the market, choosing an LMS that offers the right blend of features to meet their learners' unique needs can be daunting for an institution or program. In some cases, it is possible that LMSs might not be able to support specific teaching and learning goals/frameworks [2]. For organizations that aim to offer professional development opportunities to non-degree-seeking adult learners, the challenge becomes more complicated, as the features most vendors offer are more appropriate for K-12 and degree-seeking post-secondary learners than for non-degree-seeking adult learners. The platform must also allow instructors to deliver high-quality learning experiences using evidence-based pedagogical practices for online learning and remain relevant to that unique population of learners. This paper discusses the process of identifying and prioritizing LMS features critical to high-level learning and teaching needs in the context of a professional development program for adult learners working in specialized STEM fields. The team initially decided to build an LMS. Still, the discussion presented here can benefit any organization considering the purchase of a new LMS, or other instructional technology. It is because the process the team followed in identifying their needs can serve as a starting point for others in articulating their requirements based on their learners' needs and the learning opportunities (e.g., degree programs, non-credit certificates) they aim to offer.

It is necessary to understand the domain and level of the program for which this LMS needs analysis was conducted, as this context drove the direction of the work. As part of a multi-institution, multi-phased initiative with a mandate to deliver effective professional development covering highly specialized STEM topics to adult learners employed primarily in the defense industry, program administrators realized that the current platform used/deployed to deliver their learning experiences, which was not an LMS, would not meet the long-term needs of the program from neither a growth nor evaluation standpoint. The capacity of the platform to support the program evaluation operationally and pedagogically was a foremost consideration for them.

Thus, one of the initiative's partner institutions agreed to host the programs on an established, internally developed online platform that hosts learning resources and tools for STEM topics. With some basic LMS functionality already embedded, the platform offered more options than the previous one. Still, the project stakeholders recognized that more features and functionality were critical for the program to deliver learning experiences aligned with evidence-based teaching and learning practices and to allow for sufficient clickstream (learner analytics) data collection to support the program evaluation efforts. Because the partner institution had existing resources committed to the platform, members of the initiative's evaluation team, who were also based at the same institution at which the new platform was hosted, quickly identified that building an LMS, rather than buying one, might be the best option to serve the needs of learners,

instructors, and program administrators. In recognition of the diversion of resources devoted to maintaining the existing platform that would be needed to build a new LMS, the evaluation team completed an internal needs analysis process to confirm their initial thoughts.

Needs analysis

With those considerations and context in mind, two core evaluation team members started a needs analysis. The two members' backgrounds were well suited for the task as one is a Learning Design and Technology faculty member with over 25 years of experience working with instructional technology in multiple contexts, and the other is a senior research analyst with ten years of experience evaluating and supporting instructional technology at the post-secondary level. Both came to the project with extensive knowledge of standard features among the significant LMSs (e.g., Brightspace, Canvas, Blackboard). Though not the intent at the outset, the team's needs analysis can be organized into three phases: 1) initial analysis, 2) theoretical validation, and 3) formulation of requests. A discussion of the teams' actions in each phase follows.

As stated, the in-house platform represented a marked improvement over the previous third-party solution. However, it still had some limitations compared to the available vendor solutions, which is why project stakeholders made some informal, high-level feature recommendations to the platform team at the onset of their partnership with the platform team. The core evaluation team members leading the needs analysis used those requests, available online documentation related to the major competitor LMSs, and their extensive knowledge of LMS features as the starting point for their needs analysis, which very simply began with a list of features they would consider as relevant for non-degree seeking learners in a STEM professional development context. Before conducting a theory-informed analysis, the team reviewed their list of features their experience told them were not likely to be must-haves, such as attendance tracking, and deprioritized them. One team member then consulted colleagues working as LMS support professionals to validate their list from a practitioner standpoint. Here, it should be noted that having members of the team experienced in the capabilities of LMS and instructional technology evaluation is essential in conducting a needs analysis like the one discussed in this paper. However, a simple analysis of which existing and emerging features to adopt in the LMS was insufficient for the team as they wanted the LMS to support evidence-based pedagogical practices for teaching and learning. Thus, the team members began an analysis of these features grounded in several distinct theoretical contexts.

Despite their instructional technology expertise, the team members' primary role on the project was not to develop the LMS. Instead, they were to collaborate with the LMS development team to develop, administer, and report on an evaluation framework to assess the program's effectiveness for adult learners. Hence, the needs analysis was heavily informed by the team's development of an evaluation framework.

The evaluation framework the team developed originated from the Contextualized Framework [3], which, in its original conception, contextualizes the evaluation of learning outcomes within the interaction between course characteristics and learner characteristics present within a learning experience. The evaluation framework consists of six dimensions, including: 1) learner satisfaction, 2) learning objectives and outcomes, 3) knowledge application and usage, 4) course pedagogy, 5) broader learning impact, and 6) administration and program management. This framework was adapted from recent applications of the Contextualized Framework to large-size

online graduate-level courses for professional learners [4] that are operationalized across several survey questions delivered at different points (pre, immediate-post, one-month post, and three-month post) across each of the modalities of learning experiences (e.g., synchronous courses, webinars, self-paced online modules) offered through the program. A discussion of each of the dimensions and the additional resources informing them is beyond the scope of this paper; however, the dimensions are relevant as they represent data points the team wanted to collect within the LMS from learners as part of their program evaluation process. It is essential to note that an LMS is not necessary for data collection; however, the program team concluded that delivering surveys associated with their evaluation framework within the LMS itself would allow them to achieve the highest response rates by reducing the need for adult learners to click on a link to an external survey or answer an email. A robust LMS platform would allow for data collection and data export on a granular level.

The extent to which the Contextualized Framework informed the decision to build an LMS was not just to operationalize the evaluation framework. Looking through the lens of the Contextualized Framework, the team's primary motivation to build an LMS was to deliver learning experiences through a platform that would provide the most incredible opportunity to examine the learner characteristics component of the framework as presented in its original conception. Inspired by work related to the contextualized framework that captured learner analytics data to identify clusters of learners in MOOCs [5], the team realized that access to such rich data as discussed in that research could be challenging to obtain through vendor solutions that might limit access to advanced learner analytics data, often with additional costs beyond the basic contract agreement. In addition to the Contextualized Framework, the project team's needs analysis and the decision to build an LMS were informed by the Community of Inquiry (CoI) and Universal Design for Learning (UDL) theoretical frameworks. Both CoI and UDL served as checkpoints and guides for including or rejecting features for requests.

The Community of Inquiry (CoI) framework has generated a robust scholarly tradition that is relevant to the current online learning ecosystem of LMS, third-party instructional technology, and web-based videoconferencing and includes a validated instrument for measuring the framework's core constructs [6], [7]. The framework is formulated upon the idea that learners and instructors form a community within a learning opportunity, and learning happens at the intersection of three presences - social presence, cognitive presence, and teaching presence - they create as active members of that community [8]. In the CoI framework, social presence is a critical element of the community as it refers to the extent to which learners can "project themselves socially and emotionally" in an online learning environment [9]. Cognitive presence refers to learners' ability to construct meaning from content presented in the course and through their interactions with each other [10]. Teaching presence refers most directly to the design elements of a learning experience that "facilitate and direct" the aspects of the other two presences in the CoI framework [9].

Recently, researchers associated with the framework have drawn from cognitive and educational psychology concepts to posit that a fourth present, learning presence, be added to the framework to represent the distinct roles of teacher and learner in a learning experience [9]. Regardless of the new directions the framework takes, the types of interactions it examines and seeks to identify as contributors to effective online learning are enabled by the platform through a learning experience is delivered, so the team considered this as a foundational framework from which to validate their LMS feature requests. Additionally, the CoI framework and questions

from the validated instrument were part of the research foundations of the team's evaluation framework development.

The Universal Design for Learning (UDL) framework emerged from adaptive technology researchers' application of Universal Design, a set of architectural principles that Ron Mace developed, to their work developing electronic books [12]. Combining research in neuroscience with Vygotsky's three prerequisites for learning, Rose and Meyer [13] identify three networks within the brain (recognition networks, strategic networks, and affective networks) to formulate the UDL framework around three guiding principles meant to "minimize barriers and maximize learning through flexibility" [13].The framework's purpose is to inform educators in designing learning experiences so that those learning experiences provide intentional affordances that align with the three principles rather than reduce barriers through adaptation or accommodation after the fact [14], [15]. The framework's emphasis on flexibility by design guided the team in describing how the requested features should function and what options should be available with each feature.

With guiding theoretical frameworks identified, the team refined their initial list of features based on whether the features truly supported evidence-based pedagogical practices for online learning writ large, not just for non-degree-seeking learners in a professional development context. Though learner context has been and is a guiding principle for the team's work, a first principle transcending that consideration has been the idea that the features the team requests should align with the theoretical frameworks discussed in the previous section. This is an approach the team would have taken regardless of learner population and would serve other teams learner population and an approach that would serve other teams who are investigating LMS or other instructional technology. Further, the team knew that grounding their choices, in theory, would help them prioritize features and select a vendor solution that offered the right blend of their prioritized features if the platform team would be unable to build a new LMS. The team moved on to further prioritizing and formulating the feature requests for presentation to the team managing the platform.

In this request formulation phase of the needs analysis, three tiers of features of an LMS ideal for non-degree-seeking professionals/adult learners were identified based on functionality and relevance to the professional development context and then formulated into requests the LMS team would make to the team managing the platform. As noted earlier, the in-house platform represented a marked improvement over the previous third-party solution but had limitations. The limitations are related primarily to content presentation and interactivity, which are options necessary to create learning experiences that align with the principles of the theoretical frameworks guiding the team's work.

Thus, the team focused first on identifying and describing the most pedagogically sound implementation of the basic features learners and instructors expect from a modern LMS. Included in this first prioritization tier were assignment creation, management, and submission functionality; discussion board creation, management, and submission functionality; assessment creation with multiple question type, auto-grading, and grade scheme options; gradebook features including one-click grading, gradebook, and feedback modality (text, audio, and video) options for learners and instructors; and content management tools such as LMS and course home pages and the ability to organize course content into modules. The team requested that all assessments, assignments, discussion board topics, and modules allow instructors to make their

release conditional at a preset time/date or upon learner completion criteria, such as meeting a scoring threshold on an assignment or a quiz. Further, all creation and submission interfaces for assignments, quizzes, and discussion boards should support uploading multiple file types. The content management features requested in this tier not only support the UDL framework's principle of reducing barriers and providing flexibility, but they also support COI's construct of teaching presence by allowing instructors choice and flexibility in how the design a learning experience. The grading options requested in this tier support this construct of the COI framework similarly. Simply put, the first-tier features discussed in this paragraph determine the ways in which an instructor can structure their learning experience, thus defining what is possible in the learning experience.

The team also identified data exports related to assessments, assignments, discussion boards, and course content as a first-tier priority. The exports must identify individual learners, contextualize their actions in the LMS by time, course, and activity, and include content (e.g., posts, question choices) while readily available through the graphical user interface or to a system administrator with minimal coding knowledge. This data export functionality may be beyond what some users consider basic LMS functionality; however, it is critical to the team's evaluation efforts due to their use of the Contextualized Framework.

With the core functionality of an LMS articulated, the team next identified their second priority tier of features as those that may be present to some extent within existing LMSs but are accomplished through third-party integrations rather than available to learners seamlessly within the platform. These features include videoconferencing, instant messaging, document collaboration and storage tools, and data-informed grouping options for instructors to create learner groups based on responses to questionnaires. The features enable collaborative and interactive instructional strategies that foster the social and cognitive presence dimensions of the COI framework. Due to the professional development context, the team also identified the ability to group and sequence courses into certificates that can be awarded to learners and tracked by program administrators within the LMS as features that must be realized once the core functionality of the LMS is in place.

Finally, the team identified emerging or nonexistent features in the LMS market as their third priority for development. The focus was on features that could leverage data generated through learner actions to create visualizations and dashboards that provide learners with information they can use to enhance their professional development paths and provide instructors with data they can use to improve course and program quality. Features belonging to this tier include Social Network Analysis (SNA), which enables learners to see graphs of their interactions with other learners and instructors, Natural Language Processing (NLP), which allows learners to see themes emerging from discussions, visualizations that offer learners insight on their learning journey based on completion of past experiences and progress in ongoing experiences as well as recommendations for future courses. These features not only allow learners to see evidence of their interactions with peers and instructors, but they also inform teaching strategies. (Author, 2020)

With the features identified and prioritized, the team was inspired by the user-story approach when they documented them in writing in preparation for presenting their requests to the platform owners. The user-story concept is common to design-thinking and agile software development contexts when documenting new feature requests and design decisions before

executing the work, so stakeholders agree on the criteria for a finished product [16]. Though there is variability depending on the methods, user stories typically have three elements, including: 1) the user, 2) the specifications/ performance requirements of the feature for the user, and 3) what the user wants to accomplish through the feature or requirement [17]. The team modified this approach slightly due to the connections between the requests and the theoretical frameworks, which are discussed in the next section. The team's requests focused on potential LMS users (learners, instructors, instructional support staff, and administrators) and outlined the specifications of the feature from the user's perspective. This took the format of phrasing like learners should be able to submit assignments with a what you get is what you see editor and upload text, image, audio, and video files. When thinking of the third element of user stories (i.e., what users hope to accomplish through a feature or requirement), the team decided that the theoretical frameworks guiding their work spoke to what each user they identified hoped to accomplish through a feature. They did not include that element in their written requests to the platform team in the interest of brevity.

After articulating, prioritizing, and documenting the feature requests, the team reviewed their requests through the lenses of the three theoretical frameworks discussed earlier in this paper: Contextualized Framework, CoI, and UDL. This was to ensure that each of the requested features was necessary to support evidence-based teaching and learning in an online professional development environment. Table 1 illustrates which frameworks connect most directly to each of the general sets of features the team requested. Unsurprisingly, the team found that the first-tier priority requests, or those most elemental to an LMS, connected most strongly to the CoI and UDL frameworks as they are both very much concerned with the design and curriculum aspects of a learning experience. It followed that many of the third-tier requests, which represent a synthesis of data gathered from learners' interactions with multiple features to glean insights on learner behavior and course characteristics, most closely aligned with the Contextualized Framework.

Table 1 Connection between feature requests and theoretical frameworks

Priority	LMS Feature Set	CoI	UDL	Contextualized Framework
First Tier Requests	Assessment Features	X	X	X
	Assignment Features	X	X	X
	Discussion Boards	X	X	X
	Grading & Gradebook	X	X	X
	Content Management	X	X	X
	Release Conditions	X	X	X
	Data Exports			X
Second Tier Requests	Data Informed Grouping	X		
	Videoconferencing	X	X	
	Instant messaging	X	X	
	Document Collaboration	X	X	
	Certificates			X
Third Tier Requests	Social Network Analysis	X		X
	Natural Language Processing	X		X
	Advanced Learner Dashboards & Visualizations			X
	Advanced Instructor Dashboards & Visualizations			X

Conclusion

The LMS team presented the list of features to the platform owners knowing that the list represented their ideal state and that there would likely be compromises to be made on the road to a purpose built LMS for adult non-degree seeking learners in highly specialized STEM fields. However, after conversations with the platform development team, an option the team had not envisioned at the outset of their needs analysis emerged. Considering the amount of work needed to build a new LMS, the development team proposed adapting a third-party open-source LMS and integrating it into the existing platform. Currently, the LMS team and the platform owners are working with a vendor to build an ideal LMS from components of the existing platform and from components of the vendor solution. This approach is much like building a modular home in that one selects from the components they most want and assembles them into a finished product tailor made to their needs, which is why the LMS still views their decision as building, rather than buying an LMS. The result will be an LMS that allows for seamless navigation between the features discussed in this paper and the specialized STEM tools and content available through the existing platform. As the final product takes shape, the team will return to the program administrators who first initiated the discussion to ensure that what is created meets their needs. Despite this new modular approach and the imperative to meet the needs of additional stakeholders, the team is confident that building rather than buying is the best decision for the learners they will serve.

References

[1] R. Sabharwal, R. Chugh, M. R. Hossain, and M. Wells, “Learning Management Systems in the Workplace: A Literature Review,” in *2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)*, IEEE, 2018, pp. 387–393.

[2] H. Madiah and R. Mohemad, “A Review of Learning Management Systems (LMS) Framework Towards the Element of Outcome Based Education (OBE),” in *1ST International Postgraduate Conference on Ocean Engineering Technology and Informatics 2021 (IPCOETI 2021)*, Melville: American Institute of Physics, Mar. 2023.

[3] K. A. Douglas, H. A. Diefes-Dux, P. Bermel, K. Madhavan, N. M. Hicks, and T. V. Williams, “Board # 32: NSF PRIME project: Contextualized Evaluation of Advanced STEM MOOCs,” in *Association for Engineering Education - Engineering Library Division Papers*, Atlanta: American Society for Engineering Education-ASEE, 2017.

[4] K. A. Douglas and H. E. Merzdorf, “A framework for evaluation of large online graduate level courses for engineers,” in *ASEE Annual Conference and Exposition, Conference Proceedings*, 2020.

[5] T. V. Williams, K. A. Douglas, P. Bermel, and H. E. Merzdorf, “Beyond the Means – Visualizing Learner Activity and Outcomes for Online Instructors,” in *Association for Engineering Education - Engineering Library Division Papers*, Atlanta: American Society for Engineering Education-ASEE, 2019.

[6] J. T. Abbitt and W. J. Boone, “Gaining insight from survey data: an analysis of the community of inquiry survey using Rasch measurement techniques*,” Journal of computing in higher education*, vol. 33, no. 2, pp. 367–397, 2021.

[7] J. B. Arbaugh *et al.*, “Developing a community of inquiry instrument: Testing a measure of the Community of Inquiry framework using a multiinstitutional sample,” *The Internet and higher education*, vol. 11, no. 3, pp. 133–136, 2008.

[8] D. Randy. Garrison, T. Anderson, and W. Archer, “Critical Inquiry in a Text-Based Environment: Computer Conferencing in Higher Education,” *The Internet and higher education*, vol. 2, no. 2, pp. 87–105, 1999.

[9] G. D. Randy and J. B. Arbaugh, “Researching the community of inquiry framework: Review, issues, and future directions,” *The Internet and higher education*, vol. 10, no. 3, pp. 157–172, 2007.

[10] H. Kanuka and G. D. Randy, “Cognitive presence in online learning,” *Journal of computing in higher education*, vol. 15, no. 2, pp. 21–39, 2004.

[11] P. Shea, J. Richardson, and K. Swan, “Building bridges to advance the Community of Inquiry framework for online learning,” *Educational psychologist*, vol. 57, no. 3, pp. 148–161, 2022.

[12] D. Rose and A. Meyer, “Universal Design for Learning,” *Journal of special education technology*, vol. 15, no. 1, p. 67, 2000.

[13] D. Rose and A. Meyer, *Teaching every student in the Digital Age: universal design for learning*. Alexandria, Va: Association for Supervision and Curriculum Development, 2002.

[14] CAST, “Universal design for learning guidelines,” *CAST*, 2018.https://udlguidelines.cast.org/

[15] CAST, “Universal design for learning guidelines version 2.0 [full text],” *CAST*, 2011. https://udlguidelines.cast.org/more/downloads#v2-0

[16] R. Lawrence and P. Green, “The Humanizing Work Guide to Splitting User Stories,” *Humanizing work*, 2000. https://www.humanizingwork.com/the-humanizing-work-guide-to-splitting-user-stories/

[17] M. Cohn, *User stories applied: for agile software development*, 1st edition. Addison-Wesley, 2004.