9550-5 Attachments

Attachment for Part III of the 9550-5 Final Project Report. Fill out the MS Word template. Save and upload as a PDF.

Instructions

a. Abstracts of Theses…Self-explanatory

b. For publications (published and planned) include title, journal or other reference, date, and authors. Provide two copies of any reprints as they become available.

c. Scientific Collaborators provide a list of co-investigators, research assistants and others associated with the project. Include title or status, e.g. associate professor, graduate student, etc.

d. Briefly describe any inventions which resulted from the project and the status of pending patent applications, if any.

e. Provide a technical summary of the activities and results. The information supplied in proposals for further support, updated as necessary, may be used to fulfill this requirement.

f. Include any additional material, either specifically required in the award instrument (e.g. special technical reports or products such as films, books, studies) or which are considered to be useful to the Foundation.

a. Abstracts of Theses
(insert data here)

b. Publication Citations
(insert data here, include PDF copy of publications at the end of this document)

c. Data on Scientific Collaborators
(insert data here)

d. Information on Inventions
(insert data here)

e. Technical Summary
(insert summary of activities and results here)

f. Other (Final Report)

Final Report

Managing Training Content Including Adaptive Learning Capabilities Using 21st Century Technology

Project #CMD007 Funded by AFB-540

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The primary goal behind this project was to research and develop an example of how current methods of training for FAA employees could utilize 21st century technology to maximize training capabilities. This type of training can reduce training costs and provide the ability and adapt to changing learning environments. This project explored best practices ~~is~~ utilizing a 21st Century Learning Management System (LMS) or Learning Content Management System (LCMS) that support face-to-face learning, virtual classroom learning, and mobile learning. This system also includes the ability to handle adaptive learning, modular learning, evaluation of learning, and rapid updating capabilities.

The use of LMS/LCMS technology allows for greater customization and adaptive learning for both newly-hired and current employed FAA Aviation Safety Inspectors (ASI). This style of training will transition from a training environment to a cost-effective workforce development environment. This project is aligned with the AJI Technical Training Strategy Roadmap in three different areas: Content Platform, Process Redesign, and Technology. Within the content platform the project is viewed as part of Phase 2: Strengthen the organization and transition to enhanced training methods.

This project had five deliverables:

1. Create a report that highlights 21st Century Personalized/Adaptive Training best practices and methods and includes a technology comparative study that discusses handling of modular content.
2. Compare LMS/LCMS software from different companies to determine one that would be compatible with the needs of the FAA. Determine if the existing LMS used by the FAA is capable of delivering the desired courses in a manner consistent with

the intended use for future ASI training. If no existing LCMS is used or required, then make recommendations regarding which one(s) can meet the goals of the FAA.

3. Analyze current AFS-500 training requirements and procedures and develop a framework to assist in selecting which topics should be taught in a face-to-face setting (either in a traditional classroom setting or a virtual classroom), which topics can be best taught via online/mobile learning, and how to test for/determine topics that employees can bypass if they possess adequate knowledge of the topic.
4. Develop a prototype lesson representative of an ASI training topic that will demonstrate the use of modular and mobile adaptive learning with the ability for rapid updating.
5. Produce a final report outlining the process used and all information determined during the research project that provides recommendations and a roadmap towards a fully integrated system.

Deliverable #1:

Create a report that highlights 21st Century Personalized/Adaptive Training best practices and methods and includes a technology comparative study that discusses handling of modular content.

General recommendations regarding Adaptive Training:

1. Effective adaptive training requires sound and detailed analysis of professional learning requirements in advance; you must be clear and specific about how you want training content to be adaptive.

2. You must be highly selective when contracting an adaptive content provider to ensure a high-quality training product and to guarantee your desired results.

3. For adaptive training to be effective, you must tailor the delivery method to complement both the training content and the learner.

4. A method should be developed to allow New Hire Aviation Safety Inspectors to test out of courses if they possess proper prior knowledge of course topics.

5. A redesign of the Kirkpatrick Level 2 knowledge tests and Level 3 surveys may be needed to maximize the training effectiveness of the current training methods.

A full copy of the initial report can be found in appendix C.

Deliverable #2:

Compare LMS/LCMS software from different companies to determine one that would be compatible with the needs of the FAA. Determine if the existing LMS used by the FAA is capable of delivering the desired courses in a manner consistent with the intended use for future ASI training. If no existing LCMS is used or required, then make recommendations regarding which one(s) can meet the goals of the FAA.

After conducting peer and market research and evaluating eight (8) systems against the minimum requirements, Blackboard Learn (BB Learn), Canvas, and Desire to Learn (D2L) emerged as the potential three (3) systems to review further for the identification of all features. The features evaluated were part of the formal FAA requirements (e.g., face- to- face learning, virtual classroom learning, mobile learning, modular learning, adaptive learning, rapid content updating, evaluation of learning, other modern LMS/LCMS characteristics) and those traditionally considered under technical environment, government regulations, and interoperability standards & technologies). SuccessFactors (i.e., the FAA's eLMS) was added to the comparison after the initial report was completed because FAA clarified that eLMS is based

on the SuccessFactors LMS and not BB Learn. Currently, at the FAA, eLMS is integrated with BB Learn to provide the agency with an LCMS-type environment. The FAA course catalog is split across BB Learn and SuccessFactors. So, BB Learn serves as an LCMS only for the courses delivered in BB Learn and developed using the BB Learn authoring tool. Traditionally, course development is conducted outside of BB Learn by third-parties using other development tools and then imported into BB Learn. As a result, source files, versions, and records are stored outside of BB Learn.

The full scoresheet used to rate the features can be found in Appendix A of this report. Some features remained unrated because they were unavailable, unknown, or rejected because of IT security restrictions on Government systems. Overall, SuccessFactors had the highest weighted score of 1010.5. BB Learn had the second highest score of 953, followed by D2L and Canvas scoring 915 and 913 respectively.

Recommendations

FAA's current dual use of Blackboard Learn and SuccessFactors, coupled with the evidence collected from the rating tool leads us to propose the following recommendations, which allow FAA to support a dynamic workforce while realizing cost savings.

The FAA should:

1. Adopt Blackboard Learn as the main LCMS to implement more adaptive training methodologies and 21st-century interactive learning tools. Blackboard Learn supports face- to- face learning, virtual classroom learning, and mobile learning and includes the ability to handle modular learning, adaptive learning, rapid content updating, evaluation of learning (e.g., course analytics, performance dashboard, and retention center), and

modern LMS/LCMS characteristics such as, gamification, journals, self and peer assessments, video conferencing, and wikis.

2. Continue to use SuccessFactors as the access point for training, competency management, and other human resource activities.

Deliverable #3:

Analyze current AFS-500 training requirements and procedures and develop a framework to assist in selecting which topics should be taught in a face-to-face setting (either in a traditional classroom setting or a virtual classroom), which topics can be best taught via online/mobile learning, and how to test for/determine topics that employees can bypass if they possess adequate knowledge of the topic.

The best method to gain knowledge and to relay information has no definitive answer however, one method may be more feasible than the next. There are both benefits and drawbacks of synchronous learning, a student-teacher environment, and asynchronous learning, a self-guided study. Synchronous learning encompasses passive and active learning in both lectures and virtual classrooms. Asynchronous learning uses various materials such as books, videos, and online training to collect information at without a rigid schedule.

Synchronous learning requires both the teacher and student to be present and engaging in the learning process at a specific time. This is most commonly present in a lecture or a virtual classroom intended to recreate classroom learning environment through web-based products (Yang & Liu, 2007 as cited in Huang, Kuo, Lin, & Cheng, 2008). Synchronous learning in both lecture and virtual classroom can take on characteristics of either passive or active learning. In

the active learning concept students are engaging in the material directly, more like an open discussion than a formal lecture (Knowles, 1968 as cited in Minhas, Ghosh, & Swanzy, 2012). On the opposite spectrum, passive learning is geared more toward the traditional lecture where the teacher explains and the student absorbs the information (Minhas, Ghosh, & Swanzy, 2012).

Lectures are recognized as the most exercised use of teaching. The appeal of a lecture is that an expert in their field is able to engage an audience, and in return provoke the learning process. One of the most notable drawbacks to the traditional lecture is the lack of attendance. Because traditional lectures or guided discussions require a student and teacher to both be present at a specific location, attendance may become an issue. In order to counteract this, the virtual classroom is becoming a modern-day solution (Petrović, J., & Pale, P. 2015).

The virtual classroom is beneficial for students who have obligations or are distant from the learning center, such as students who are working full time, have children to take care, or are too ill to attend class in person (Bower et al., 2015). This flexibility from the design of the virtual classroom increases attendance which in return helps increase motivation (Bower et al. 2015). This motivation increase can result to higher grades. The US Department of Education states that student performance increases overall in online learning environments than in face-to-face environments (Kruger-Ross & Waters, 2013). Unfortunately, synchronous online learning is not always feasible. It is restricted by time because both teacher and student must be able to log on to an online classroom and engage (Huang et al., 2008). Another key issue with the virtual classroom is the platform itself. The student must be familiarized with the web-based platform and have the technical skills in place in order to properly use it (Bower et al., 2015). Another major issue with virtual classrooms and synchronous learning, is availability of bandwidth. If there is lag or disconnection this will hinder the progress of learning (Huang et al.,2008).

Asynchronous distance learning relies on different materials, usually electronic, to reach learners at any point in time or at any location. This allows the most flexibility for students and educators (Huang et al., 2008). In addition to flexibility, some of the benefits of asynchronous learning includes cost effectiveness, the ability to utilize several different resources, and is preferred method of learning of millennials (Gómez-Rey et al.,2017). The largest drawback to asynchronous learning is the lack of a social environment. The lack of peers and teachers present can make knowledge sharing difficult and the learning environment much more isolated (Bower et al, 2015).

While textbooks may have originated for classroom purposes, they have now evolved into an anytime-anywhere resource, including e-books. A benefit to textbooks is the structure they provide, and thus a guideline for what should be learned and progress within that book. Since a textbook is able to be read at any time, the student is able to independently study at his or her own pace (Lau et al, 2018). A major drawback to textbooks or e-books is the inability to cater concepts and expression of ideas to individuals based on learning styles and needs. (Graves, 2000).

Unlike a textbook, Computer based training (CBT) allows the user to experience information in multiple forms such as through sounds, narrations, text, pictures, videos, and so forth. Computer based training is becoming more common in today's society and is increasing in popularity to various generations. One of the largest benefits to CBT includes high-level learning in which both visual and verbal processing systems are combined to the working memory. However, CBT should be chosen with the audience in mind because an older audience may respond differently to the CBT than a younger audience (Wallen & Mulloy, 2006).

Videos have become a tool in education, and a great source for self-study. Being able to stop, reflect, rewind and review material has become beneficial not only to all students but also to those who may be struggling with new terms or language. (Draper, Gibbon, & Thomas, 2018). Videos used to review or teach initial concepts seems to be very beneficial however when used to learn a technique it may have drawbacks. Students may mimic the video behaviors and process without realizing the concepts or developing a deeper understanding of the subject (Ganier & de Vries, 2016).

Both synchronous and asynchronous learning have benefits and drawbacks. In order to achieve the best retention and learning, both should be utilized for a curriculum. A student-teacher learning environment is extremely valuable, however is due to time is not always feasible. On the other-hand asynchronous learning provides a plethora of resources with flexibility but no social interaction. If used together a student will receive the benefits of both methods while experiencing minimal drawbacks. CBTs can be used to effectively provide introductory information and help develop student comprehension and understanding. In classroom learning time is valuable and best spent allowing the student to practice and further develop skills instead of using that time for introductory knowledge. A balance of CBT asynchronous learning and classroom synchronous learning is the best combination to teach material effectively.

Deliverable #4:

Develop a prototype lesson representative of an ASI training topic that will demonstrate the use of modular and mobile adaptive learning with the ability for rapid updating.

A review of current courses available to ASIs was conducted and a list of five potential courses were selected as a possible subject for a prototype lesson. After discussion with FAA course developers and determination of availability of appropriate course files, the course about 14 CFR Part 141 Pilot Schools (27100049) was chosen as the topic for the prototype lesson. Development of the course was completed on a representative version of Blackboard hosted by Inter-American University. The course was beta tested by approximately 30 people with backgrounds ranging from FAA employees, flight instructors, aviation professors, and aviation students. Feedback was obtained and used to finalize the course.

The course was split into three learning modules, two of which had a pre-test. If the student achieved a score of 70% or higher on the pre-test, they could skip the learning module and move on to the next pre-test. If the student scored lower than 70% on any of the pre-tests, they had to take the learning module and the introductory module and complete the course post-test with a score of 70% or higher. If a score of less than 70% was achieved on the course post-test, the student would need to review the relevant course material indicated in the question feedback and retake the test until obtaining a score of 70% or higher.

An export of the Blackboard course was provided that could be uploaded into the FAA's version of blackboard for further review and as an example course. The development process and considerations can be found in Appendix B of this report.

Deliverable #5:

Produce a final report outlining the process used and all information determined during the research project that provides recommendations and a roadmap towards a fully integrated system.

This report, through research and development of the sample online course, provides the FAA with a framework on new training possibilities using adaptive training and modular course development. Using this style of training has many benefits including a reduction in training time and cost, a more personalized training for individual ASIs, and modular course design which will reduce the time and cost needed to update courses. Transitioning to this type of learning environment will allow a move forward to use 21st century technology to maximize training capabilities within the FAA.

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Appendix A – LMS/LCMS Features Rating Tool

Instructions

To use the matrix:

1. Replace the top row ([SPECIFY LMS 1], [SPECIFY LMS 2], etc.) with the names of the systems you have identified for final consideration.
2. For each Weight cell in the column to the right of the Feature name, enter a number between 1-3 to weight the relative importance of that feature to FAA (the higher the number, the more important).

   Weighting Factor

   3 = Must Have; 2 = Should Have; 1 = Nice to Have; 0 = Not Applicable
3. For each Rating cell, enter a number between 1-5 to rate the degree to which each system has that feature (the higher the number, the more "out of the box" it is).

   Scoring

   5 = Automatic (built-in, out of the box feature)
   4 = Semi-Automatic (mostly built-in, but requires some programming or customization to activate)
   3 = Semi-custom (partially available. The system can be adapted to implement this feature through moderate customization)
   2 = Custom (not available but can be added, possibly at a high cost, with programming)
   1 = Not Available (would be impossible or cost-prohibitive to customize the system to add the feature due to incompatibilities with system architecture, etc.)
4. The rollup score row at the bottom will provide the total weighted score for each system. Formulas in the cells multiply the weighting factor for each feature by the degree of implementation feature described above; those scores are then added to make the totals at the bottom of each row.

NO.	REQUIREMENTS	Weight	BLACKBOARD LEARN		CANVAS		D2L BRIGHTSPACE		SUCCESSFACTORS/eLMS	
			Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
1	**TECHNICAL**									
1.1	IP Blocker	3	5	**15**	4	**12**	1	**3**	5	**15**
1.2	Anti-spam	3	5	**15**		**0**	5	**15**	5	**15**
1.3	Anti-virus	3		**0**		**0**	5	**15**	5	**15**
1.4	Strong Passwords	3	5	**15**	5	**15**	5	**15**	5	**15**
1.5	Restrict registration to specific domains	3		**0**	5	**15**		**0**	5	**15**
1.6	Security Certification & Accreditation/Compliance	3	5	**15**	5	**15**	5	**15**	5	**15**
1.7	Transport Layer Security (TLS)	3	5	**15**	5	**15**	5	**15**	5	**15**
1.8	Public-Key Infrastructure (PKI)	3	5	**15**		**0**		**0**	5	**15**
1.9	Federal Information Processing Standard (FIPS – 140-1)	3		**0**		**0**		**0**	5	**15**

NO.	REQUIREMENTS	Weight	BLACKBOARD LEARN		CANVAS		D2L BRIGHTSPACE		SUCCESSFACTORS/eLMS	
			Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
2	**FACE-TO-FACE (CLASSROOM) COURSES**									
2.1	Build multiple classes/sections/cohorts for a single course	3	5	**15**	5	**15**	5	**15**	5	**15**
2.2	Enable learners to self-register from a list of available classes	3	5	**15**	5	**15**	5	**15**	5	**15**
2.3	Classroom waitlist feature with administrator tools	3	5	**15**	5	**15**	5	**15**	5	**15**
2.4	Instructors can retrieve training item	3		**0**		**0**		**0**	5	**15**
2.5	Capture attendees via an electronic class roster/attendance tool	3	5	**15**	5	**15**	5	**15**	5	**15**
2.6	Integrate class registration with Outlook calendars	3		**0**		**0**		**0**	5	**15**
3	**VIRTUAL CLASSROOM LEARNING**	3	5	**15**	5	**15**	5	**15**	5	**15**
4	**MOBILE LEARNING**	3	5	**15**	5	**15**	5	**15**	5	**15**
5	**MODULAR LEARNING**	3	5	**15**	5	**15**	5	**15**	5	**15**
6	**ADAPTIVE LEARNING**									
6.1	Provides a course opt-in feature that can be used for pre- and post-tests	3		**0**	2	**6**		**0**	5	**15**
6.2	Generates dynamic personalized learning pathways for each learner	2	3	**6**	5	**10**	3	**6**	5	**10**
6.3	Recommends content using machine learning and big data	2	2	**4**	5	**10**	3	**6**	5	**10**
6.4	Assignments can be assigned to specific learners	2		**0**	5	**10**	5	**10**	5	**10**
6.5	Content and assignments can be denoted as required or optional	2		**0**	5	**10**		**0**	5	**10**
6.6	Learners can customize their training by selecting content and assignments within a learning path	2		**0**	5	**10**	5	**10**	5	**10**
6.7	Hide/show content based on assessment scores and mastery	2	5	**10**	5	**10**	5	**10**	5	**10**
6.8	Supplemental materials can be automatically released to learners based on performance on quizzes or assignments	2	5	**10**	5	**10**	5	**10**	5	**10**
6.9	Seamlessly integrated with the automation system	2		**0**		**0**	5	**10**	5	**10**
7	**RAPID UPDATING (AUTHORING)**									
7.1	Built-in content authoring	3	5	**15**	5	**15**	5	**15**	5	**15**
7.2	Reusable Learning Objects (e.g., assessments, PPTs, PDFs, surveys, tasks, videos)	3	5	**15**	5	**15**	5	**15**	5	**15**

NO.	REQUIREMENTS	Weight	BLACKBOARD LEARN		CANVAS		D2L BRIGHTSPACE		SUCCESSFACTORS/eLMS	
			Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
8	**EVALUATION OF LEARNING**									
8.1	Reporting functionality tool to create standard reports on users, completions, training activities, courses, and qualifications	3	5	**15**	5	**15**		**0**	5	**15**
8.2	Export data in Excel format for further processing	3	5	**15**	5	**15**	5	**15**	5	**15**
8.3	Automated scheduling and e-mail reports to users	3	5	**15**	2	**6**		**0**	5	**15**
8.4	Ability to schedule report delivery to senior level management	3		**0**	2	**6**		**0**	5	**15**
8.5	Tracking functionality for all users, training, and curricula	3	5	**15**	5	**15**		**0**	5	**15**
8.6	Qualification and resource management	3		**0**	5	**15**		**0**	5	**15**
9	**DASHBOARDS**	3	5	**15**	5	**15**	5	**15**	5	**15**
10	**OFFLINE ACCESS (DISCONNECTED MOBILE APP)**	2	1	**2**	5	**10**	5	**10**	1	**2**
11	**WEB-BASED/MOBILE ADMINISTRATION**	2		**0**		**0**	5	**10**		**0**
12	**CERTIFICATES**									
12.1	Allows administrator design/upload and learner delivery of course completion certificates	3	5	**15**	5	**15**	5	**15**	5	**15**
12.2	Allows easy printing of certificates	3	5	**15**	5	**15**	5	**15**	5	**15**
13	**COMPETENCY MANAGEMENT**									
13.1	Supports competency management	3	5	**15**		**0**	4	**12**	5	**15**
13.2	Evaluates competencies after learning	3	5	**15**		**0**	5	**15**	5	**15**
13.3	Automatically links training interventions and competency objects based on user approval	3		**0**		**0**	5	**15**	5	**15**
13.4	Imports/exports competency-related data in common database formats such as XML or MS Access	3		**0**		**0**		**0**	5	**15**
13.5	Prioritizes competencies and courses based on changes in career, regulations, funding, or organizational vision/mission	3		**0**		**0**		**0**	5	**15**
13.6	Can import competency inventories and rubrics as well as learner data from external systems	3		**0**		**0**		**0**	5	**15**
13.7	Uses a variety of competency frameworks (e.g., 360-degree Feedback)	3		**0**		**0**		**0**	5	**15**

NO.	REQUIREMENTS	Weight	BLACKBOARD LEARN		CANVAS		D2L BRIGHTSPACE		SUCCESSFACTORS/eLMS	
			Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
13.8	Can provide IDP progress, training completion, and other related input to competency management, performance appraisal and other HR components of other systems	3		**0**		**0**	5	**15**	5	**15**
13.9	Can provide automated analysis/assessment survey of student's current and anticipated skills and competencies. Gaps are identified with appropriate courses indicated to address closure of gap(s)	3		**0**		**0**	5	**15**	5	**15**
14	**COLLABORATION AND COMMUNICATION**									
14.1	Allows learners to take notes as they interact with learning materials. These notes should be persistent between sessions and automatically associated with locations in the content. If the learner wishes, their notes can be posted, either internally in the LMS, or publicly outside of the LMS, through APIs to applications like Twitter and Facebook.	2		**0**		**2**	1	**2**	1	**2**
14.2	Includes collaboration functions to enable users to communicate with each other, instructors, course administrators, system administrators, etc. These functions typically include:									
14.2.1	Chat/Instant messenger (IM)	3	1	**3**	5	**15**	5	**15**	1	**3**
14.2.2	Threaded discussion and Blogs									
14.2.2.1	Attach documents associated with a posting (students)	3	5	**15**	5	**15**	5	**15**	5	**15**
14.2.2.2	Embed links (students)	3	5	**15**	5	**15**	5	**15**		**0**
14.2.2.3	Allow creation of groups (instructors)	3	5	**15**	5	**15**	5	**15**		**0**
14.2.2.4	Make postings anonymous and/or private that cannot be viewed by anyone higher in the organizational hierarchy (i.e., vertical social network)	0	5	**0**	1	**0**	5	**0**		**0**
14.2.2.5	Search (students and instructors)	3	5	**15**	3	**9**	5	**15**		**0**
14.2.2.6	Set release conditions (instructors)	3	5	**15**	5	**15**	5	**15**		**0**
14.2.2.7	Moderate (instructors)	3	5	**15**	2	**6**	5	**15**		**0**
14.2.2.8	Use rubrics to grade postings (instructors)	3	5	**15**	5	**15**	5	**15**		**0**

NO.	REQUIREMENTS	Weight	BLACKBOARD LEARN		CANVAS		D2L BRIGHTSPACE		SUCCESSFACTORS/eLMS	
			Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
14.2.3	File sharing									
14.2.3.1	Allows learners to include comment tags	2	5	**10**	1	**2**	5	**10**		**0**
14.2.3.2	Allow check-in and check-out version controls	3	5	**15**	1	**3**		**0**		**0**
14.2.3.3	Incorporates a user rating system (for relevancy, quality, etc.)	1	5	**5**		**0**		**0**		**0**
14.2.3.4	Accepts a variety of file types, such as;									
14.2.3.4.1	PDF	3	5	**15**	5	**15**	5	**15**		**0**
14.2.3.4.2	Video	3	5	**15**	5	**15**	5	**15**		**0**
14.2.3.4.3	Web pages	3	5	**15**	5	**15**	5	**15**		**0**
14.2.3.4.4	MS Office	3	5	**15**	5	**15**	5	**15**		**0**
14.2.3.4.5	Zip archives	3	5	**15**	5	**15**	5	**15**		**0**
14.2.4	Journals	1	5	**5**	1	**1**	4	**4**	1	**1**
14.2.5	Social networking	1	5	**5**	3	**3**		**0**	1	**1**
14.2.6	Communities of practice (CoPs) or dedicated team spaces	2		**0**		**0**		**0**	1	**2**
14.2.7	Community calendar	1.5		**0**		**0**		**0**	1	**1.5**
14.2.8	Surveys	2	5	**10**	5	**10**	5	**10**	5	**10**
14.2.9	Peer rating of content	3	5	**15**	5	**15**		**0**	5	**15**
14.2.10	Video Conferencing	3	4	**12**		**0**		**0**	1	**3**
14.2.11	Learner to learner whiteboard	3	5	**15**		**0**		**0**	1	**3**
14.2.12	Desktop sharing	2	5	**10**		**0**		**0**	1	**2**
14.3	Provides infrastructure for coaching, mentoring, and other informal learning paradigms	3		**0**		**0**		**0**		**0**

NO.	REQUIREMENTS	Weight	BLACKBOARD LEARN		CANVAS		D2L BRIGHTSPACE		SUCCESSFACTORS/eLMS	
			Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
15	**GAMIFICATION**									
15.1	Badges	2	5	**10**	2	**4**	5	**10**	2	**4**
15.2	Badge customization	2	5	**10**	2	**4**	5	**10**	2	**4**
15.3	Points	2	2	**4**	2	**4**	5	**10**	2	**4**
15.5	Levels	2	5	**10**	2	**4**	1	**2**	2	**4**
15.6	Leaderboards	2	2	**4**	2	**4**	5	**10**	2	**4**
15.7	Customize Gamification mechanic	2	2	**4**	2	**4**	5	**10**	2	**4**
16	**THIRD-PARTY INTEGRATIONS**									
16.1	MS Office 365 (Onedrive, Outlook, Word, Excel, PowerPoint)	3	3	**9**	3	**9**	5	**15**		**0**
16.2	Adobe Connect	3		**0**	4	**12**	4	**12**		**0**
16.3	Google Apps (Gmail, Calendar, Drive, Docs, Slides)	1	4	**4**	4	**4**	5	**5**		**0**
16.5	SharePoint	2		**0**		**0**	1	**2**		**0**
16.7	Skillsoft	3	1	**3**	1	**3**	1	**3**	5	**15**
16.8	Twitter	0		**0**	5	**0**	1	**0**	1	**0**
16.9	Skype	0		**0**	5	**0**	1	**0**	1	**0**
16.10	SMS	0		**0**	4	**0**	1	**0**	1	**0**
16.11	YouTube	0	4	**0**	4	**0**	4	**0**	1	**0**
16.12	Vimeo	0	4	**0**	4	**0**	4	**0**	1	**0**
16.13	LinkedIn	0		**0**	5	**0**	1	**0**	1	**0**
16.14	Big Blue Button (Opensource Web Conferencing System)	0	4	**0**	5	**0**	4	**0**	1	**0**
16.15	ExamView	0		**0**		**0**		**0**		**0**
16.16	LaTex (Mathematics)	1	4	**4**	5	**5**	4	**4**	1	**1**
16.17	Flickr	0		**0**	4	**0**	1	**0**	1	**0**
16.18	WebCT (Blackboard Vista)	1		**0**	5	**5**	1	**1**		**0**
16.19	Blackboard	3	0	**0**	5	**15**	1	**3**	5	**15**
16.20	Angel	1		**0**	5	**5**	1	**1**		**0**

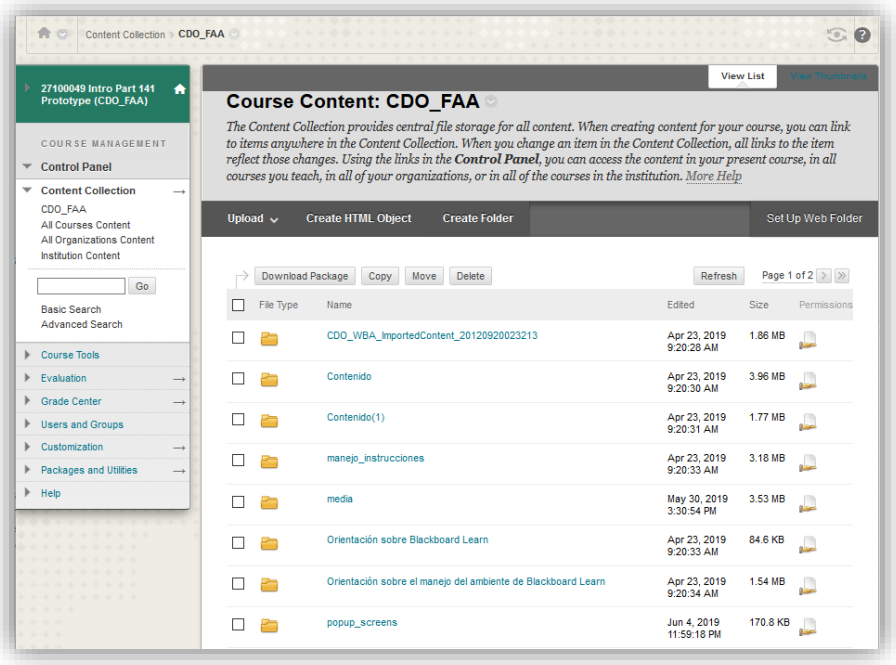
NO.	REQUIREMENTS	Weight	BLACKBOARD LEARN		CANVAS		D2L BRIGHTSPACE		SUCCESSFACTORS/eLMS	
			Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
16.21	Moodle 1.9/2.x	3	5	**15**	5	**15**	1	**3**	5	**15**
16.22	D2L	1	5	**5**	5	**5**	0	**0**		**0**
16.23	Student Response Systems (e.g. TurningPoint Technologies)	1	3	**3**	3	**3**	3	**3**	5	**5**
16.24	Zapier	0		**0**		**0**		**0**		**0**
16.25	GoToMeeting	0		**0**		**0**		**0**		**0**
16.26	WebEx	0		**0**		**0**		**0**	4	**0**
16.27	GoToTraining	0		**0**		**0**		**0**		**0**
16.28	Zoom	0		**0**	4	**0**	4	**0**		**0**
16.29	MailChimp	0		**0**		**0**		**0**		**0**
16.30	Turnitin	1	2	**2**	5	**5**	4	**4**		**0**
16.31	iCal	2		**0**		**0**		**0**		**0**
17	**GOVERNMENT REGULATIONS**									
17.1	Section 508	3	4	**12**	5	**15**	5	**15**	5	**15**
17.2	Privacy Act	3	5	**15**	5	**15**	5	**15**	5	**15**
18	**INTEROPERABILITY STANDARDS & TECHNOLOGIES**									
18.1	AICC	3	5	**15**	5	**15**	5	**15**	5	**15**
18.2	Tin Can (xAPI)	3	5	**15**	5	**15**	5	**15**	5	**15**
18.3	Single Sign-On (SSO) based on the SAML2 and LDAP Authentication	3	5	**15**	5	**15**	5	**15**	5	**15**
18.4	Active Directory	3	5	**15**	5	**15**	5	**15**	5	**15**
18.5	Central Authentication Service (CAS) Authentication	3	4	**12**	4	**12**	4	**12**	5	**15**
18.6	LMS Learning Tools Interoperability (LTI) Standard	3	5	**15**	5	**15**	5	**15**	5	**15**
18.7	SCORM:									
18.7.1	Is certified or has been tested for conformance.	3	5	**15**	5	**15**	5	**15**	5	**15**
18.7.2	Support all SCORM data model elements (SCORM 2004)	3	5	**15**	5	**15**	5	**15**	5	**15**
18.7.3	Retains visibility for the TOC when a SCO has been launched	3	5	**15**		**0**		**0**	5	**15**
18.7.4	Shows both — “attempted” status as well as —”completion.”	3	5	**15**		**0**		**0**	5	**15**

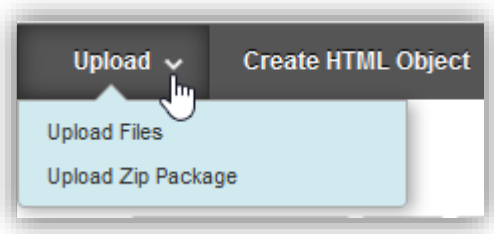
NO.	REQUIREMENTS	Weight	BLACKBOARD LEARN		CANVAS		D2L BRIGHTSPACE		SUCCESSFACTORS/eLMS	
			Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
18.7.5	Is not overly proprietary in its implementation and handling of SCORM calls other than —attemptedǁ and —completion.”	3		**0**		**0**		**0**		**0**
18.8	Supports multi-byte (Unicode) fonts (esp. Asian language characters) and right-to-left languages. This requires that the LMS interface text is stored as data, separate from source code.	3		**0**	5	**15**		**0**		**0**
18.9	Offers flavors of the interface in foreign languages for global reach	3	5	**15**	5	**15**	4	**12**	5	**15**
18.10	Supports the Training and Learning Architecture (TLA). See 5.12.7 Training and Learning Architecture (TLA)	3		**0**		**0**		**0**	5	**15**
	Total			**953**		**913**		**915**		**1010.5**

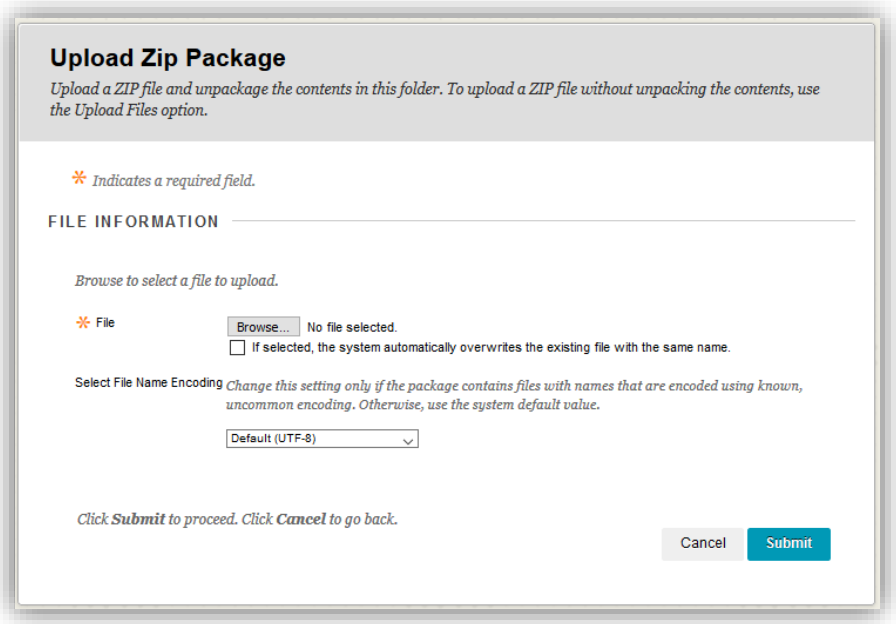
Appendix B – LMS/LCMS Courseware Development Process

☐Get access to selected LMS/LCMS for development of Prototype.
☐Become familiar with BB Learn functionality (e.g., BB Learn online help, YouTube etc.)
☐Gather and organize existing multimedia elements into a folder.
☐Upload multimedia elements to the appropriate subfolders in the LMS content collection area/files storage.

ISD created a media subfolder for multimedia elements (e.g., PDFs and graphics) and a popup screens subfolder for popup information and elements. Files can be imported individually or as a Zip package. Keep in mind that when a Zip file is uploaded the contents will be unpacked in the current folder. Make sure you're in the folder you intend to save the files to before importing the Zip package.



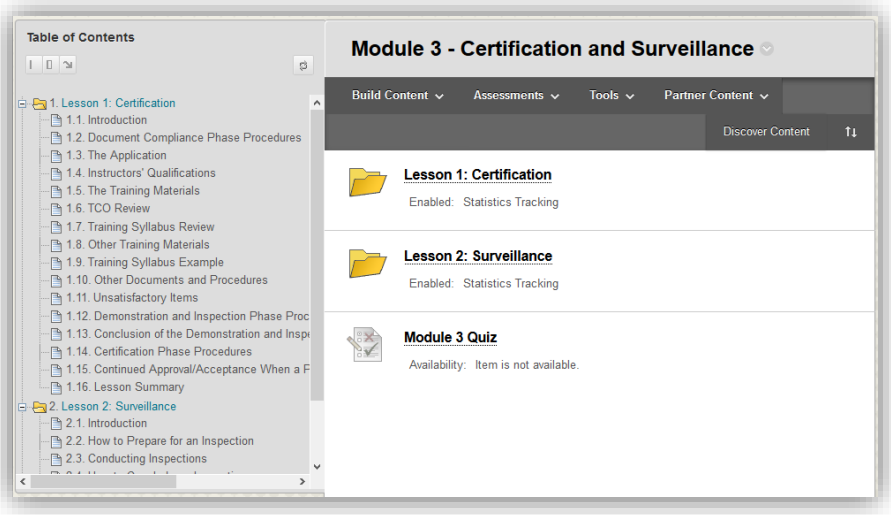




☐Plan course structure/flow for these components.

- ☐Optional: Create Course Flowchart
- ☐Pre-Tests
- ☐Learning Modules

  For modules with multiple lessons, consider organizing each lesson within a folder.



☐Module Knowledge Checks

☐Post- (Mastery) Test

☐Plan Adaptive Release Settings.

Settings (or rules) may be set related to availability, date and time, individual users, group membership, scores or attempts on any Grade Center item, calculated columns in Grade Center, or review status of an item in the course. Be careful about the number and combination of release options as doing so may cause issues with intended course availability.

☐Course

☐During Development - based on individual users or group membership for testing purposes

☐After Development - based on date and time

Prototype pilot: 6/6/19, 9 a.m. - 6/11/19, end of day; later extended to 6/13/19, end of day due to limited participation.

☐Learning Modules

☐Based on pre-test scores; 70% or more needed to skip module

☐Select Grade Center column

☐Select Condition - percent

☐Specify range - **0 - 69**

☐Post- (Mastery) Test

☐Based upon at least one attempt on a Module 2 Quiz OR Module 3 Quiz

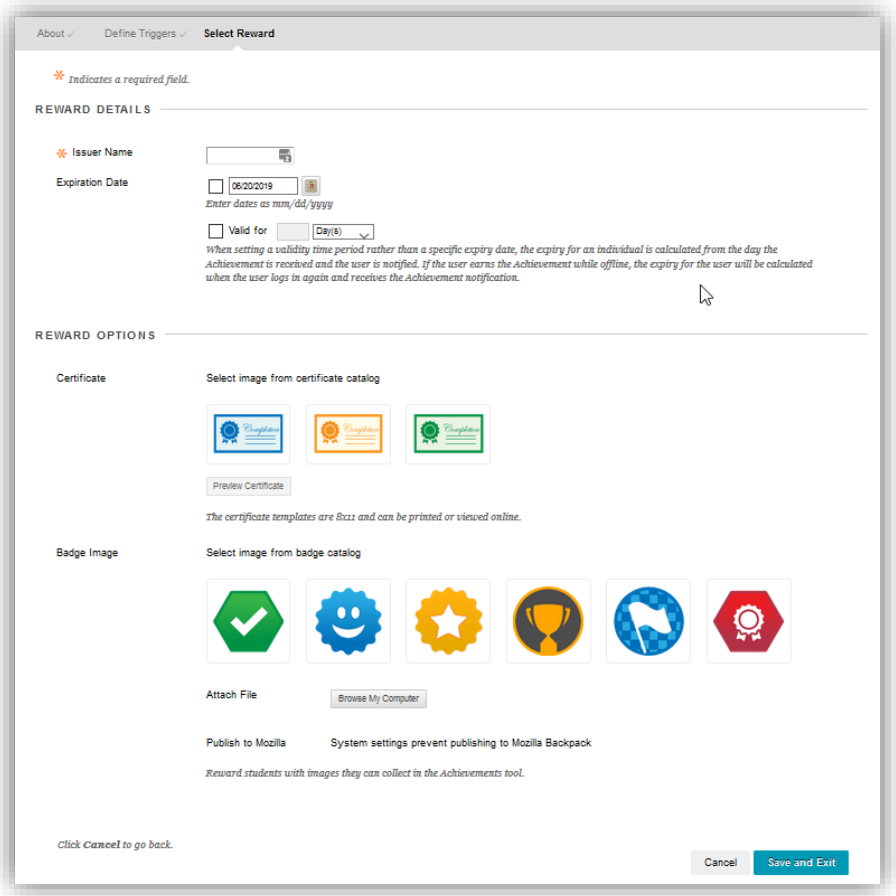
☐Determine test options settings.

Test options control the instructions, availability, due dates, feedback, self-assessment and presentation of the test.

☐Plan Achievements.

Each achievement must have at least one rule that triggers the release of the specified reward when completed. Complete the general about information for the achievement, define one or more triggers, and select one or more rewards for successful completion.

- ☐Decide on issuer name, expiration dates, and reward options
  Can use default certificates and badges or create custom ones.
- ☐Course Completion
  - ☐Achievement: Course Completion
    - ☐Trigger: Course Completion
- ☐Module 2
  - ☐Achievement: Module 2 Pre-Test **Bronze**
    - ☐Description: Well Done! You've passed the pre-test. No need to complete Module 2- Introduction to Part 141 Pilot Schools.
    - ☐Trigger: Grade for Module 2 Pre-Test between 70 and 80
  - ☐Achievement: Module 2 Pre-Test **Silver**
    - ☐Description: Good Job! You've passed the pre-test. No need to complete *Module 2 - Introduction to Part 141 Pilot Schools*.
    - ☐Trigger: Grade for Module 2 Pre-Test between 81 and 90
  - ☐Achievement: Module 2 Pre-Test **Gold**
    - ☐Description: Congratulations! You've passed the pre-test. No need to complete *Module 2 - Introduction to Part 141 Pilot Schools.*
    - ☐Trigger: Grade for Module 2 Pre-Test between 91 and 100
- ☐Module 3
  - ☐Achievement: Module 3 Pre-Test **Bronze**
    - ☐Trigger: Grade for Module 2 Pre-Test between 70 and 80
  - ☐Achievement: Module 3 Pre-Test **Silver**
    - ☐Trigger: Grade for Module 2 Pre-Test between 81 and 90
  - ☐Achievement: Module 3 Pre-Test **Gold**
    - ☐Trigger: Grade for Module 3 Pre-Test between 91 and 100



☐Write instructions to add to *Start Here* page.

This course is adaptive so you will complete specific modules, or none at all, depending on how much you scored on the module pre-tests.

The course will open with the learning modules, which consists of two pre-tests, three learning modules, a mastery test, and course evaluation.

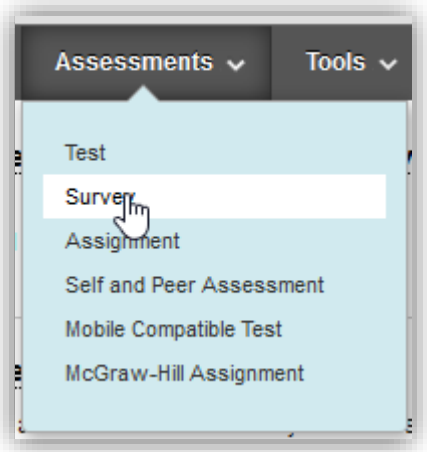
Begin by launching the Module 2 pre-test. To start the Module 2 pre-test, click on the Module 2 Pre-Test word/icon. Note that Module 2 - Introduction to Part 141 Pilot Schools: Part 141 Pilot Schools is not available until after the module pre-test is marked complete.

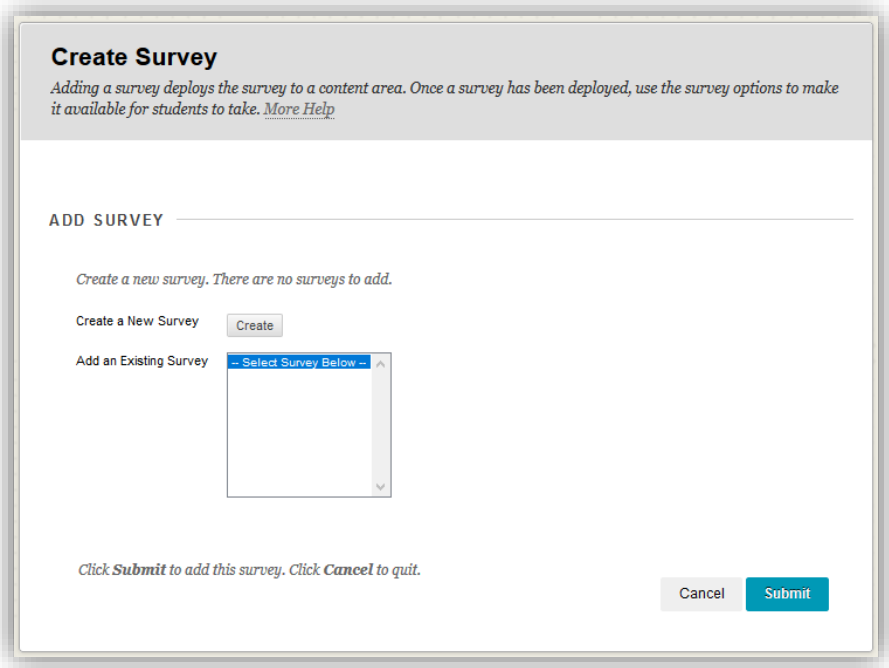
You will then be prompted to begin the pre-test. You must complete it entirely to continue. You only have one attempt, and the results will be displayed after completion. This assessment is an 8 question multiple-choice test to determine your understanding of Part 141 pilot schools. If you achieve less than 70%, Module 2 - Introduction to Part 141 Pilot Schools: Part 141 Pilot Schools will be activated for you to complete, in addition to Module 1 - Introduction: Course Overview.

After you have completed the Module 2 pre-test, you can either start Module 2, if you achieved less than 70% or launch the Module 3 pre-test, which is also an 8 question multiple-choice test. This pre-test checks your understanding of the certification and surveillance of Part 141 pilot schools. If you achieve less than 70%, Module 3 - Certification and Surveillance will be activated for you to complete.

Upon completion of your specified modules, take the Mastery Test and Prototype Evaluation.
If you achieved at least 70% on both pre-tests you don't have to complete any of the modules. Jump to the Prototype Evaluation to share with us your experience while taking the course.

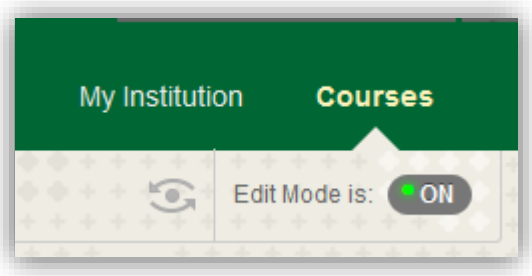
☐Create Evaluation Survey



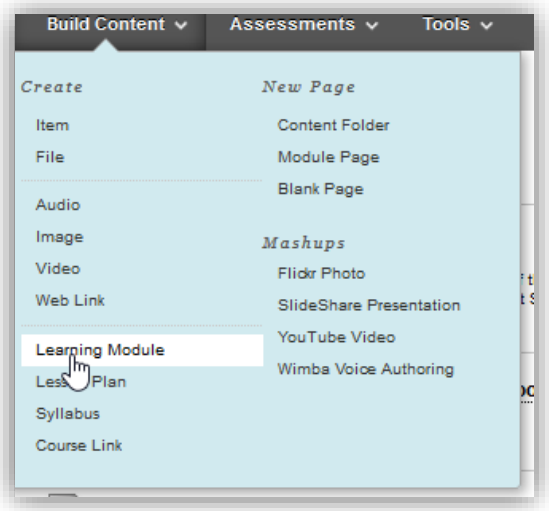


☐Set up course structure in BB Learn.

Make sure you're in edit mode.



☐Build content.



☐Create

- ☐Glossary
- ☐Resources

☐Create/Edit *Start Here* page

- ☐Existing course
  - ☐Create content pages
    - ☐Copy/Paste content into Notepad (*.txt* files)

      Using Notepad allows copied text to be free of any underlying proprietary code and for approved formatting and styles to be applied via the content editor. This might be okay if there are no plans to provide custom CSS or to use the built-in LMS classes.
    - ☐Build Item > Create Item
      - ☐Name item
      - ☐Copy/Paste content from Notepad into Content Editor
      - ☐Add multimedia
      - ☐Apply approved styles and formatting
      - ☐Set Standard Options

        Set content visibility, tracking views, and date and time restrictions.
        - ☐Enable Track Number of Views
  - ☐Create popup files
    - ☐Copy/Paste content into Notepad (*.txt* files) and Save to a folder of your choice on your computer

      Creating the popups ahead of time saves time during the linking process. Consider linking to eCFRs, similar to what was done for the Resources page, instead of using copy of the text in popups.
    - ☐Change file extensions from *.txt* to *.html*
    - ☐Zip the contents
    - ☐Upload it to a subfolder of your choice in the LMS content collection area/files storage
    - ☐Use the Content Editor to write, format and style content
- ☐New course
  - ☐Create course outline
  - ☐Gather course content sources
  - ☐Create multimedia elements
  - ☐Upload multimedia elements to LMS content collection area/files storage
  - ☐Create popup files
  - ☐Upload popup files to LMS content collection area/files storage
  - ☐Use the Content Editor to write, format and style content

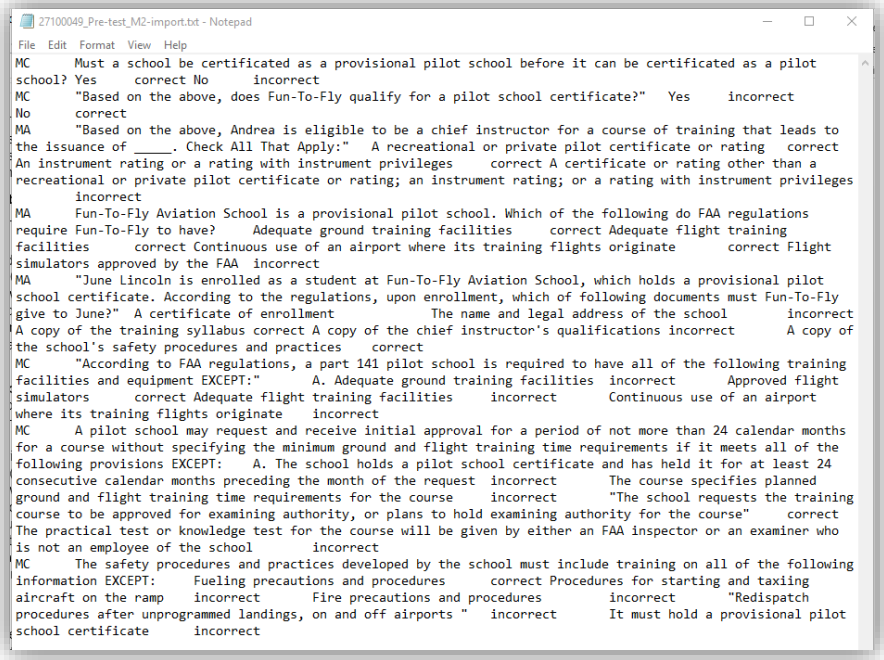
    Can be done in MS Word but underlying proprietary code will carry over when pasted into the Content Editor. This might be okay if there are no plans to provide custom CSS or to use the built-in LMS classes.

☐Create, import, and edit tests.

The Test Canvas allows you to add and edit questions, add question sets or random blocks, reorder questions, and review the test.

☐Create a tab delimited text file for each assessment (can be created and edited in Excel) for import in to the LMS

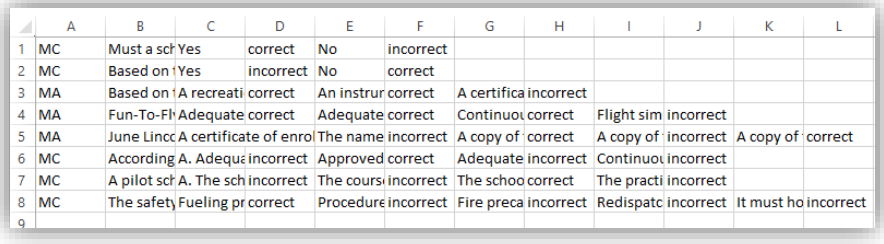
- ☐M2 Pre-Test
- ☐M3 Pre-Test
- ☐Post- (Mastery) Test



27100049_Pre-test_M2-import.txt - Notepad

File Edit Format View Help

```
MC      Must a school be certificated as a provisional pilot school before it can be certificated as a pilot
school? Yes     correct No      incorrect
MC      "Based on the above, does Fun-To-Fly qualify for a pilot school certificate?"   Yes     incorrect
No      correct
MA      "Based on the above, Andrea is eligible to be a chief instructor for a course of training that leads to
the issuance of _____. Check All That Apply:"   A recreational or private pilot certificate or rating   correct
An instrument rating or a rating with instrument privileges     correct A certificate or rating other than a
recreational or private pilot certificate or rating; an instrument rating; or a rating with instrument privileges
        incorrect
MA      Fun-To-Fly Aviation School is a provisional pilot school. Which of the following do FAA regulations
require Fun-To-Fly to have?     Adequate ground training facilities     correct Adequate flight training
facilities      correct Continuous use of an airport where its training flights originate       correct Flight
simulators approved by the FAA  incorrect
MA      "June Lincoln is enrolled as a student at Fun-To-Fly Aviation School, which holds a provisional pilot
school certificate. According to the regulations, upon enrollment, which of following documents must Fun-To-Fly
give to June?"  A certificate of enrollment             The name and legal address of the school        incorrect
A copy of the training syllabus correct A copy of the chief instructor's qualifications incorrect       A copy of
the school's safety procedures and practices    correct
MC      "According to FAA regulations, a part 141 pilot school is required to have all of the following training
facilities and equipment EXCEPT:"       A. Adequate ground training facilities  incorrect       Approved flight
simulators      correct Adequate flight training facilities     incorrect       Continuous use of an airport
where its training flights originate    incorrect
MC      A pilot school may request and receive initial approval for a period of not more than 24 calendar months
for a course without specifying the minimum ground and flight training time requirements if it meets all of the
following provisions EXCEPT:    A. The school holds a pilot school certificate and has held it for at least 24
consecutive calendar months preceding the month of the request  incorrect       The course specifies planned
ground and flight training time requirements for the course     incorrect       "The school requests the training
course to be approved for examining authority, or plans to hold examining authority for the course"     correct
The practical test or knowledge test for the course will be given by either an FAA inspector or an examiner who
is not an employee of the school        incorrect
MC      The safety procedures and practices developed by the school must include training on all of the following
information EXCEPT:     Fueling precautions and procedures      correct Procedures for starting and taxiing
aircraft on the ramp    incorrect       Fire precautions and procedures         incorrect       "Redispatch
procedures after unprogrammed landings, on and off airports "   incorrect       It must hold a provisional pilot
school certificate      incorrect
```

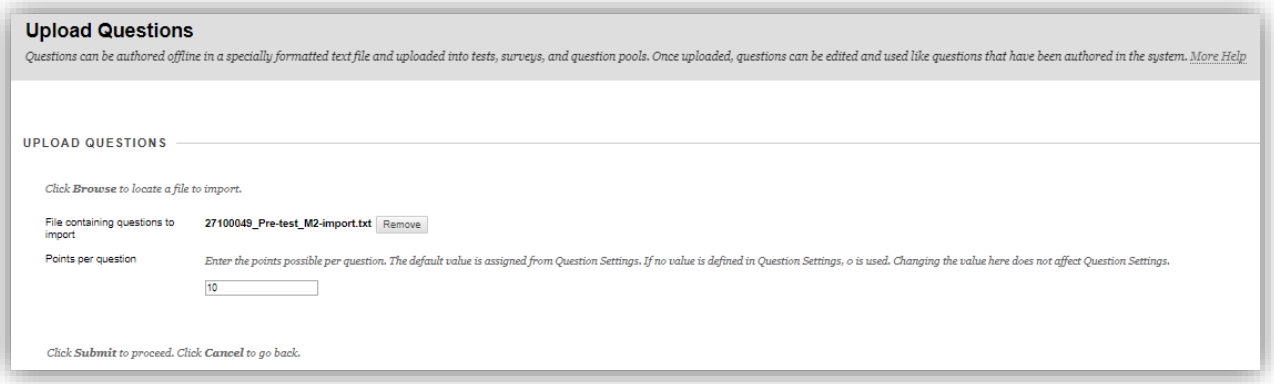


	A	B	C	D	E	F	G	H	I	J	K	L
1	MC	Must a sch	Yes	correct	No	incorrect						
2	MC	Based on t	Yes	incorrect	No	correct						
3	MA	Based on t	A recreati	correct	An instrur	correct	A certifica	incorrect				
4	MA	Fun-To-Fl	Adequate	correct	Adequate	correct	Continuou	correct	Flight sim	incorrect		
5	MA	June Linc	A certificate of enrol		The name	incorrect	A copy of	correct	A copy of	incorrect	A copy of	correct
6	MC	According	A. Adequa	incorrect	Approved	correct	Adequate	incorrect	Continuou	incorrect		
7	MC	A pilot sch	A. The sch	incorrect	The cours	incorrect	The schoo	correct	The practi	incorrect		
8	MC	The safety	Fueling pr	correct	Procedure	incorrect	Fire preca	incorrect	Redispatc	incorrect	It must ho	incorrect
9												

☐Import/upload tests (tab delimited text file)

- ☐M2 Pre-Test
- ☐M3 Pre-Test

☐Post- (Mastery) Test



☐Create module quizzes

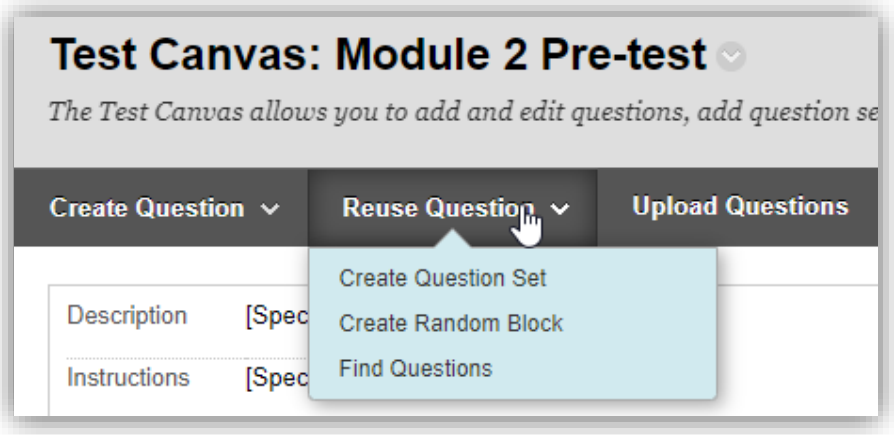
Did not identify a way to add knowledge checks after chunks of content so added them at the end.

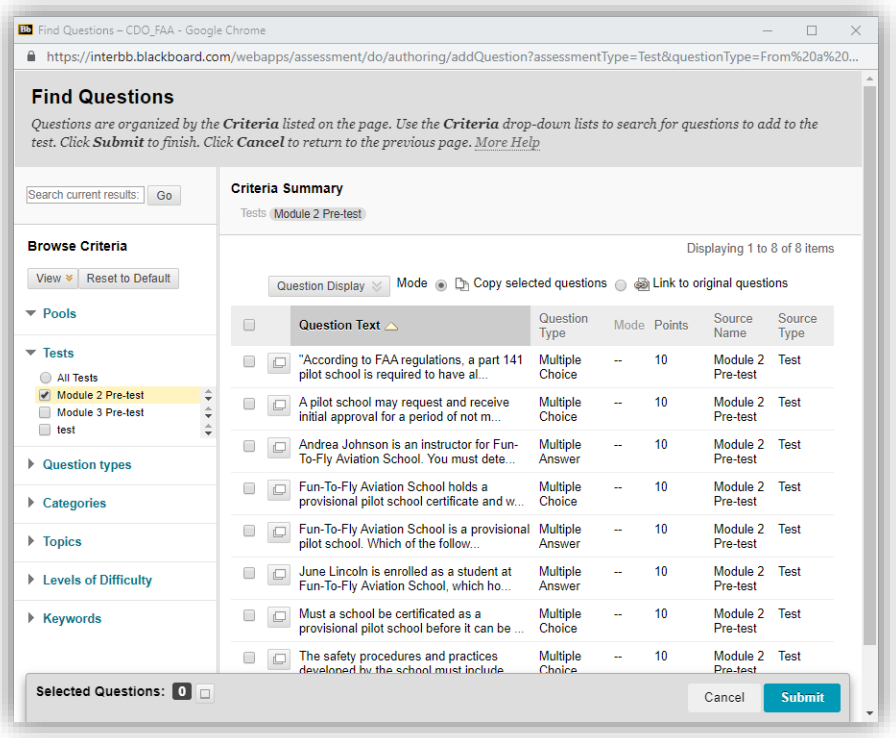
☐Create questions

☐Reuse questions

☐M2 Quiz

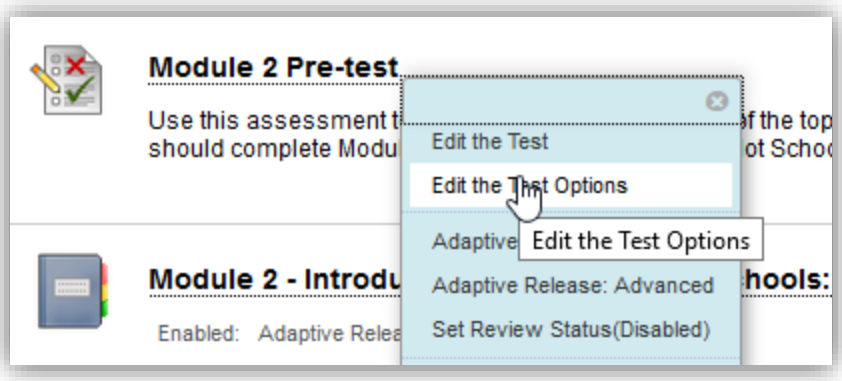
☐M3 Quiz

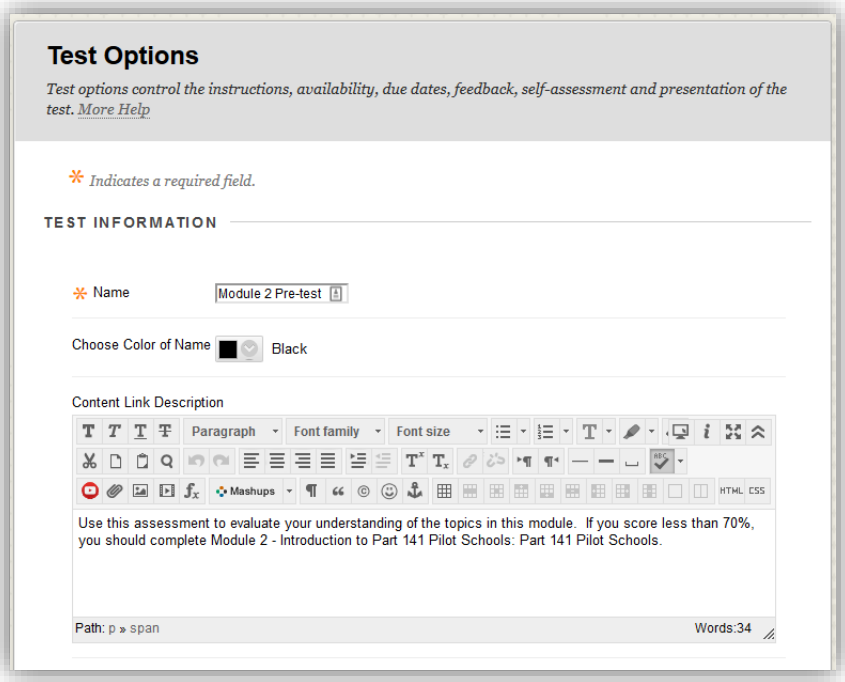




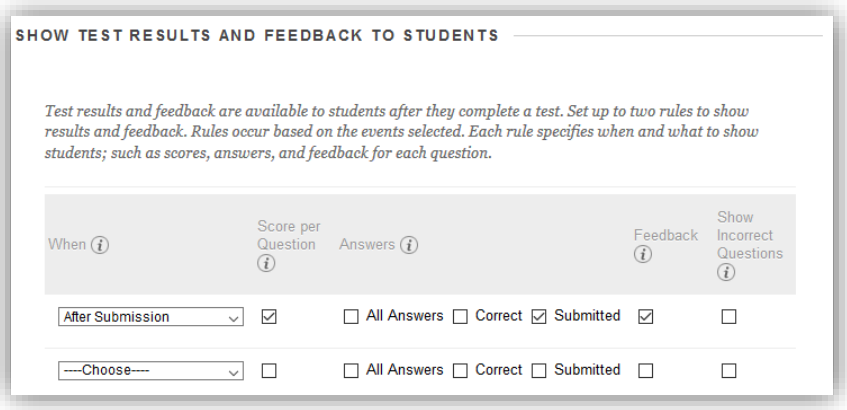
☐Edit test options.

Set instructions, availability, due dates, feedback, self-assessment and test presentation. The chosen feedback options shown in the graphic for the pre-tests were chosen to hide the correct answer(s) since these those questions are reused in the module quiz. Feedback consisted of "Correct" or "Incorrect" only.

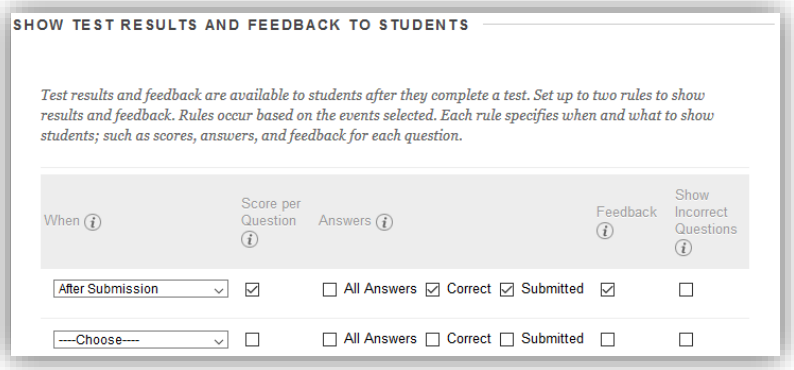




☐M2 Pre-Test
☐M3 Pre-Test



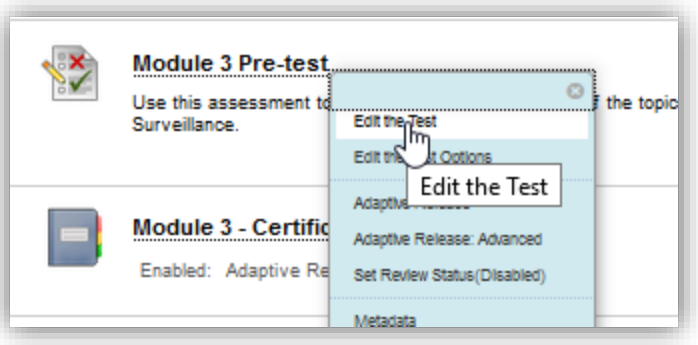
☐M2 Quiz
☐M3 Quiz
☐Post- (Mastery) Test

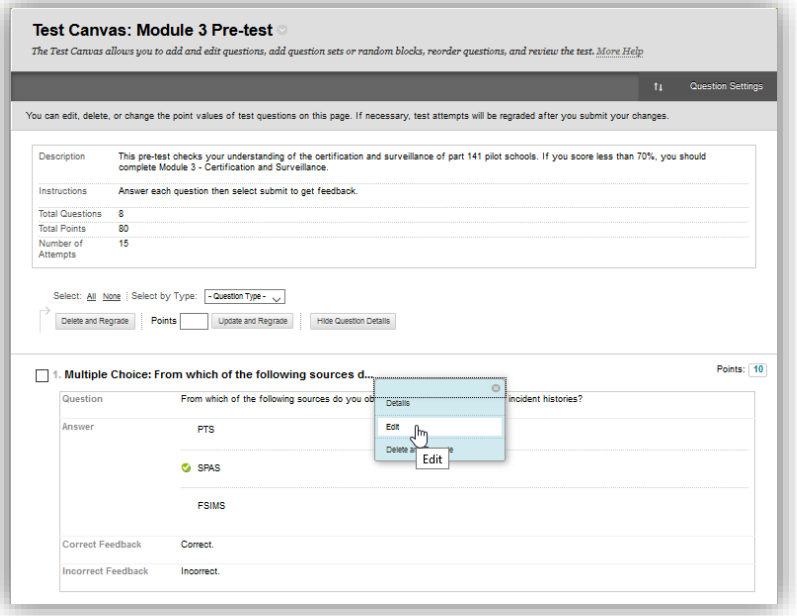


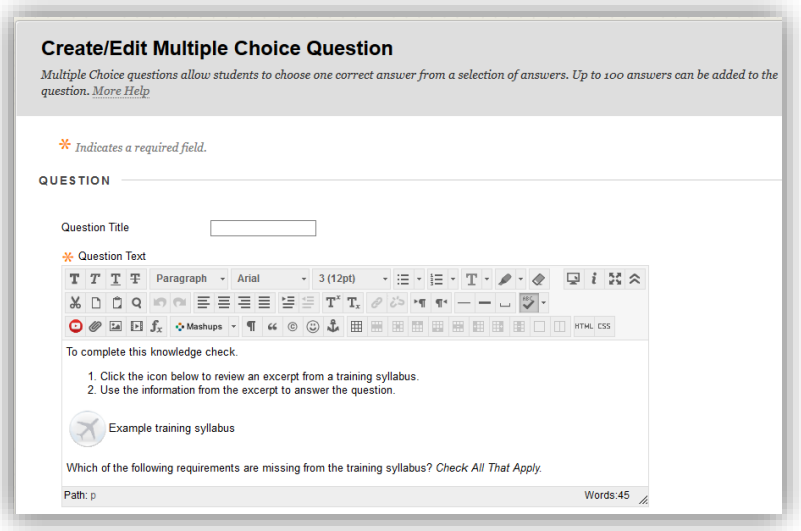
☐Edit tests.

This is an opportunity to format and style content and to add supporting resources (e.g., URLs, documents, and images) needed to answer the question.

☐M2 Pre-Test
☐M2 Quiz
☐M3 Pre-Test
☐M3 Quiz
☐Post- (Mastery) Test


Module 3 Pre-test
Use this assessment to
the topic
Surveillance.
Edit the Test
Edit the Test
Adaptive Release: Advanced
Set Review Status(Disabled)
Metadata
Module 3 - Certific
Enabled: Adaptive Re

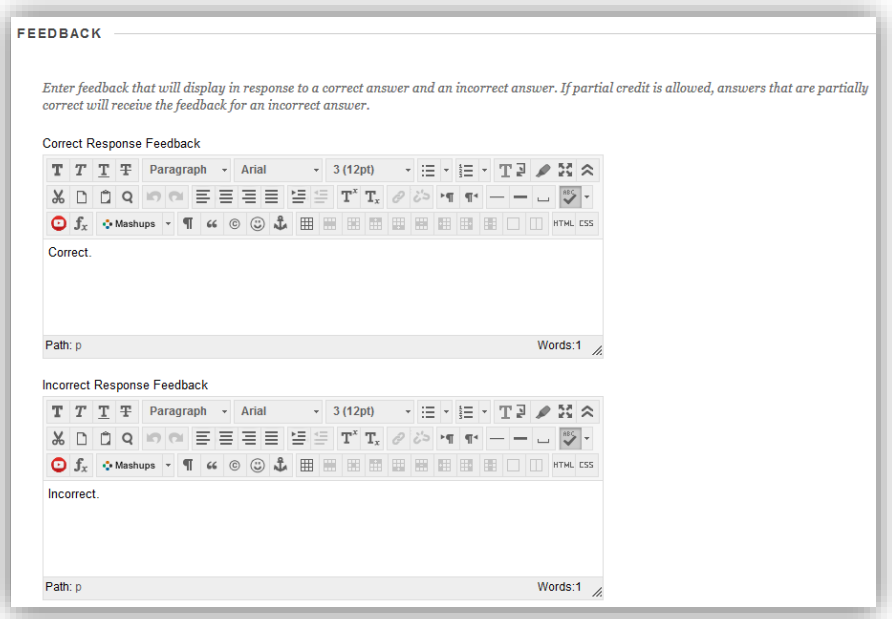

Test Canvas: Module 3 Pre-test
The Test Canvas allows you to add and edit questions, add question sets or random blocks, reorder questions, and review the test. More Help
Question Settings
You can edit, delete, or change the point values of test questions on this page. If necessary, test attempts will be regraded after you submit your changes.
Description
This pre-test checks your understanding of the certification and surveillance of part 141 pilot schools. If you score less than 70%, you should complete Module 3 - Certification and Surveillance.
Instructions
Answer each question then select submit to get feedback.
Total Questions 8
Total Points 80
Number of Attempts 15
Select: All None | Select by Type: - Question Type -
Delete and Regrade
Points
Update and Regrade
Hide Question Details
1. Multiple Choice: From which of the following sources d...
Points: 10
Question
From which of the following sources do you ob... incident histories?
Details
Edit
Edit
Answer
PTS
SPAS
FSIMS
Correct Feedback
Correct.
Incorrect Feedback
Incorrect.



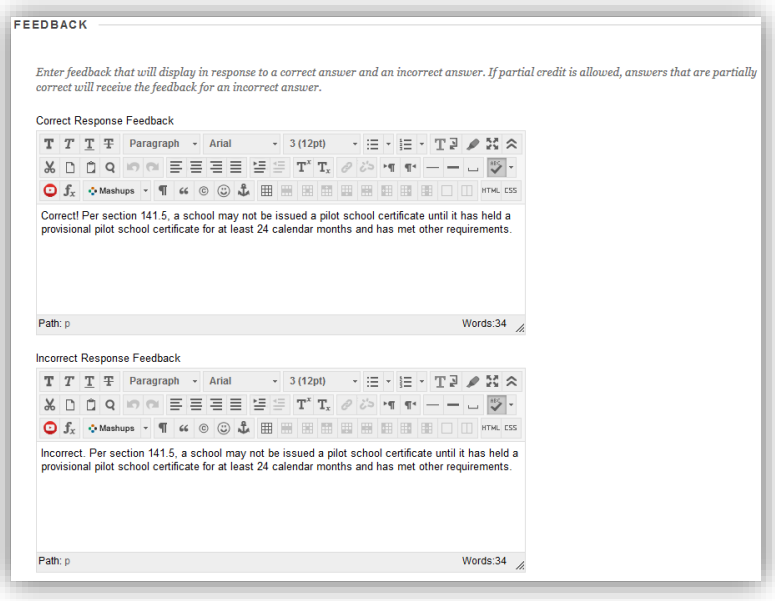
☐Add feedback for each item

- ☐M3 Pre-Test
- ☐M2 Pre-Test

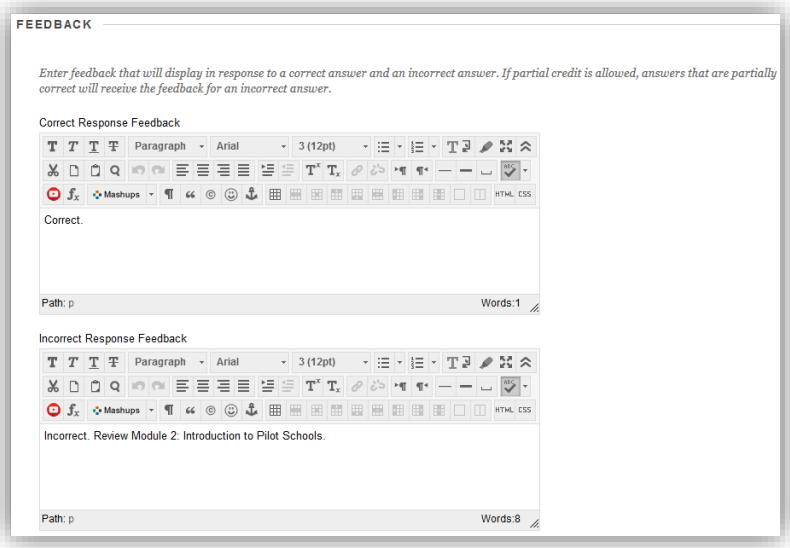
"Correct" or "Incorrect", only for the pre-tests. In this Prototype, the questions from each module's pre-test were reused. More specific feedback was reserved for the module quizzes.



☐M2 Quiz
☐M3 Quiz



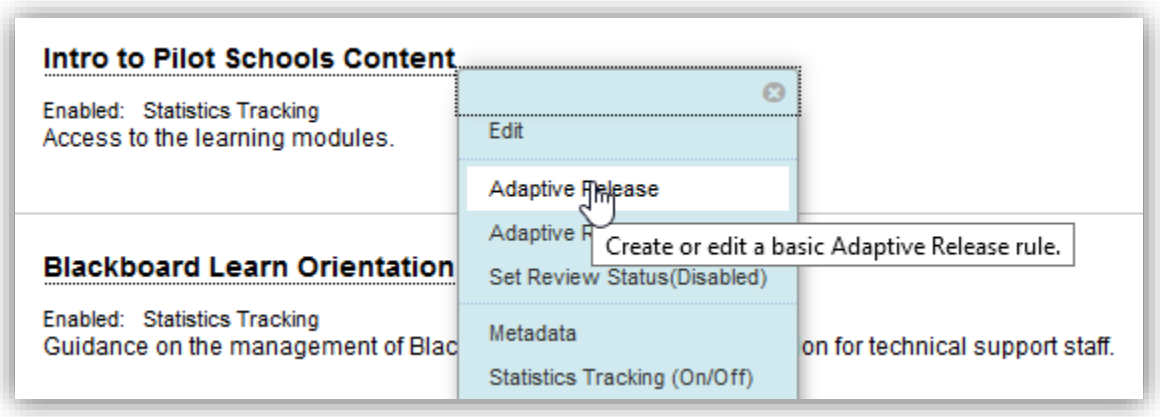
☐Post- (Mastery) Test

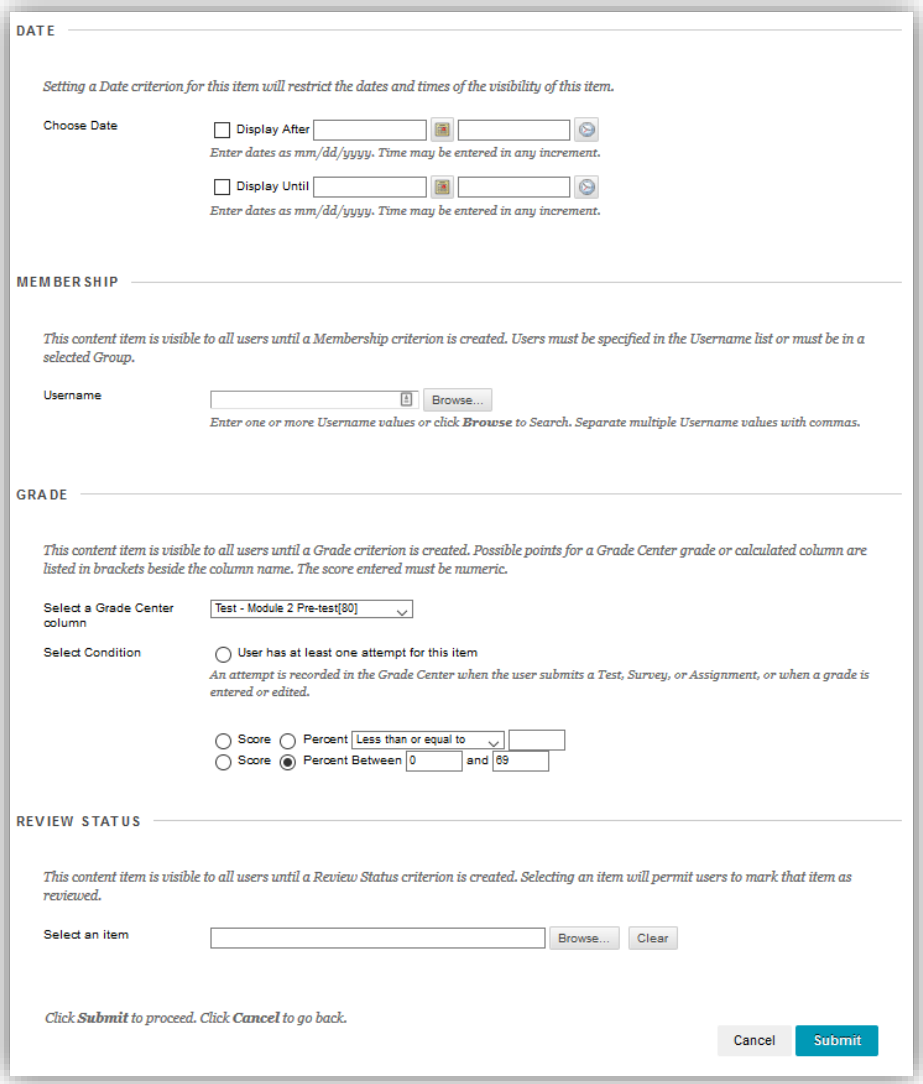


☐Apply adaptive release settings.

- ☐Course
- ☐Learning Modules
- ☐Post- (Mastery) Test

Could not selectively release the post- (Mastery) test based on attempts on either Module 2 or Module 3 quizzes because functionality for "OR" parameter non-existent in this version of BB Learn when creating multiple rules.




DATE
Setting a Date criterion for this item will restrict the dates and times of the visibility of this item.
Choose Date
Display After
Enter dates as mm/dd/yyyy. Time may be entered in any increment.
Display Until
Enter dates as mm/dd/yyyy. Time may be entered in any increment.
MEMBERSHIP
This content item is visible to all users until a Membership criterion is created. Users must be specified in the Username list or must be in a selected Group.
Username
Browse...
Enter one or more Username values or click Browse to Search. Separate multiple Username values with commas.
GRADE
This content item is visible to all users until a Grade criterion is created. Possible points for a Grade Center grade or calculated column are listed in brackets beside the column name. The score entered must be numeric.
Select a Grade Center column
Test - Module 2 Pre-test[80]
Select Condition
User has at least one attempt for this item
An attempt is recorded in the Grade Center when the user submits a Test, Survey, or Assignment, or when a grade is entered or edited.
Score Percent Less than or equal to
Score Percent Between 0 and 89
REVIEW STATUS
This content item is visible to all users until a Review Status criterion is created. Selecting an item will permit users to mark that item as reviewed.
Select an item
Browse...
Clear
Click Submit to proceed. Click Cancel to go back.
Cancel
Submit

☐Add these links to the course Menu/sidebar.

Could not add links to the Menu/Sidebar because the functionality was disabled.

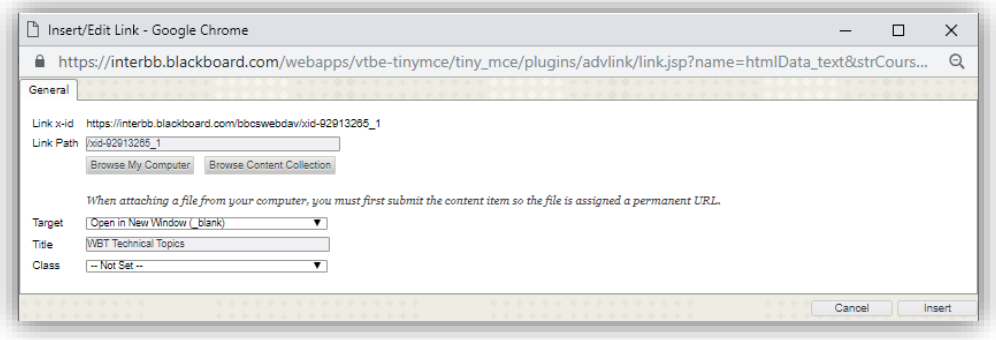
- ☐Glossary
- ☐Resources

☐Perform quality checks.

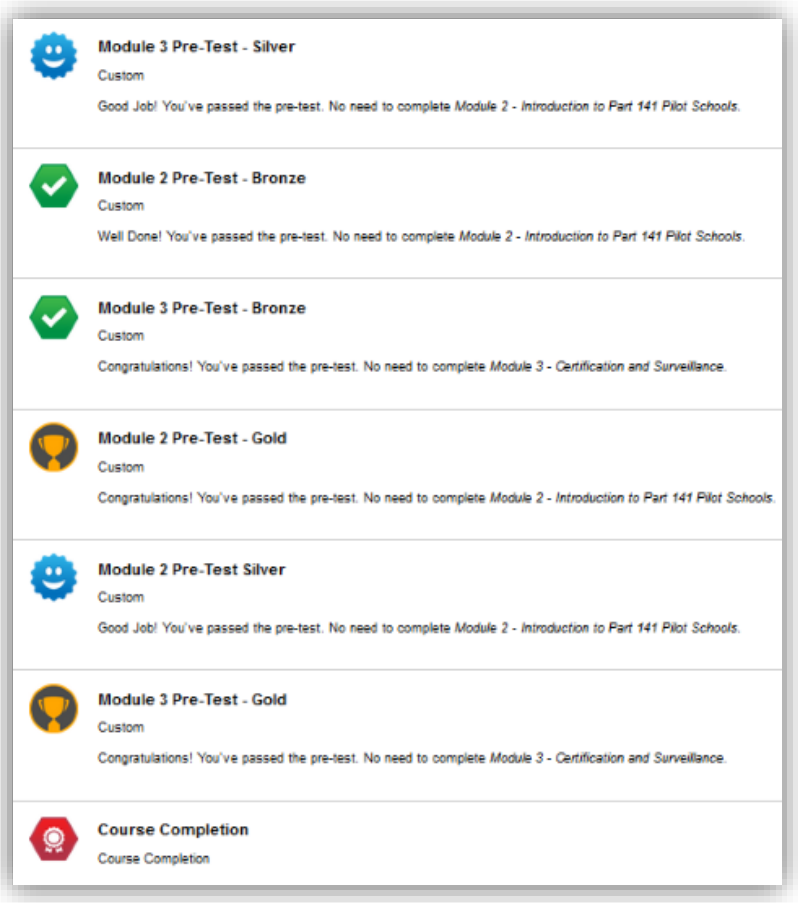
- ☐Course structure/flow
- ☐Verify that all assessments are included in the Grade Center
- ☐Adaptive release settings

  Recommend the Skip Tool/Feature to be deployed in BB Learn instance to be used when students score more than 70% on the Pre-Test. Due to the university's instance of BB Learn not having the Skip Feature, instructions were added to the Start Here page.
- ☐Assessments; verify settings, answers and feedback

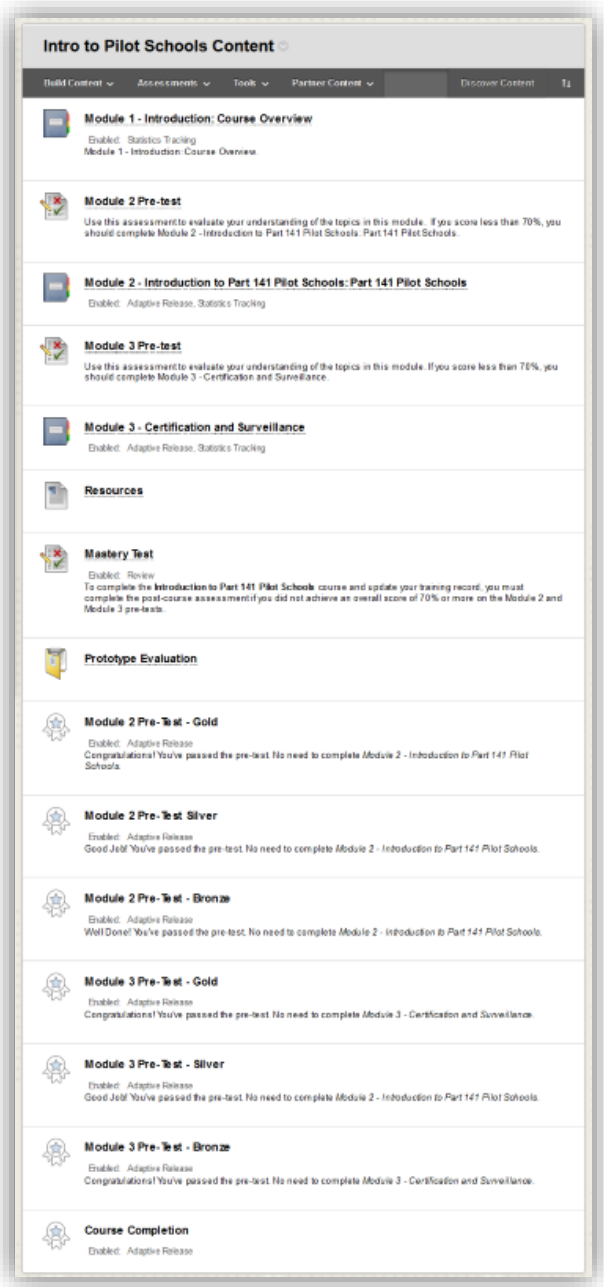
  Save Answer button available; Answers save automatically after a few seconds if user did not click on the Save Answer button before proceeding to another question.
  - ☐M2 Pre-Test
  - ☐M2 Quiz
  - ☐M3 Pre-Test
  - ☐M3 Quiz
  - ☐Post- (Mastery) Test
- ☐Alt Text



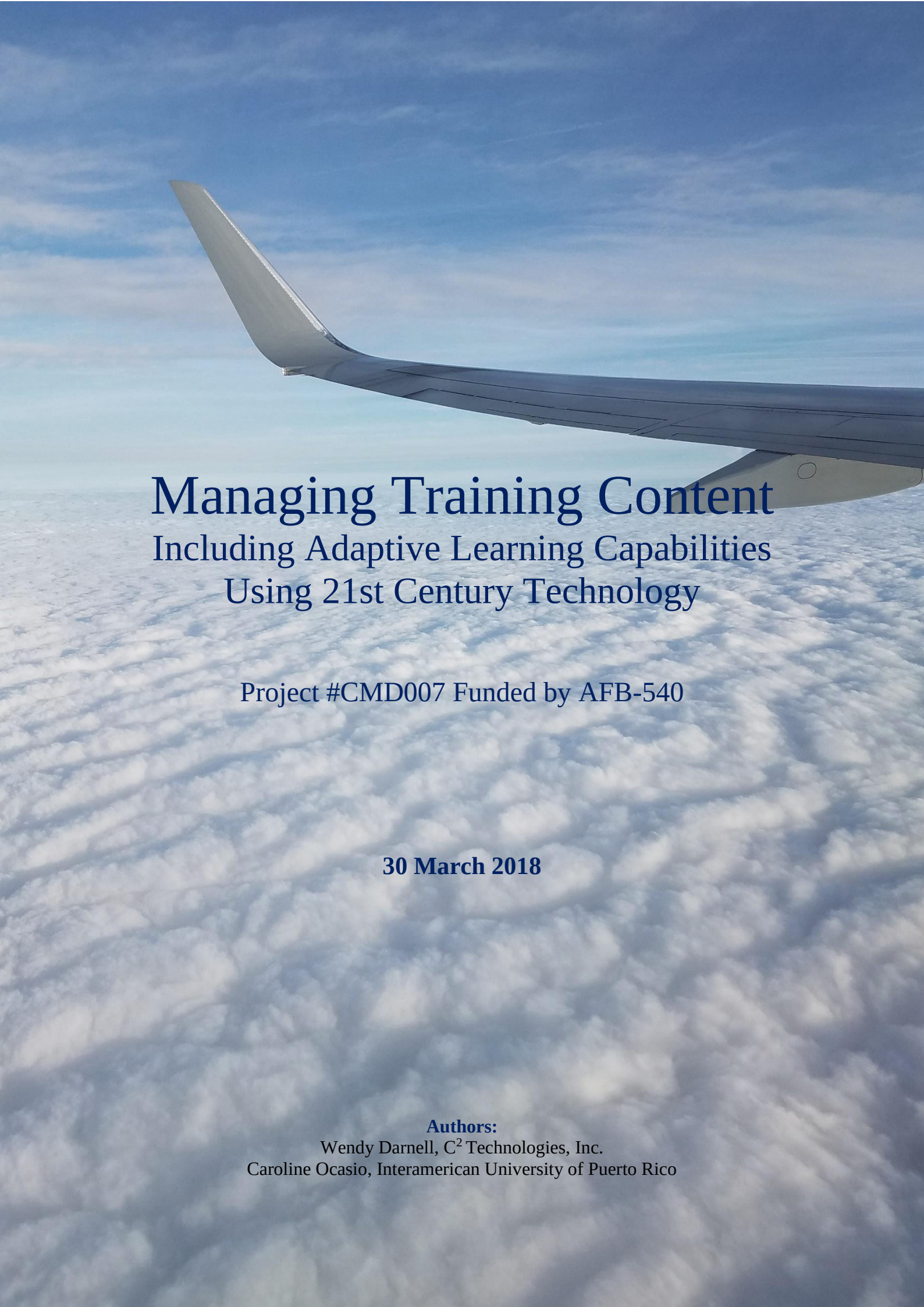
☐Achievements



☐Test the course.
☐Review change requests.
☐Implement approved change requests and verify changes.
☐Delete individual user adaptive setting for all learning modules and tests if needed before course goes live.


Intro to Pilot Schools Content
Build Content
Assessments
Tools
Partner Content
Discover Content
Module 1 - Introduction: Course Overview
Enabled: Statistics Tracking
Module 1 - Introduction: Course Overview
Module 2 Pre-test
Use this assessment to evaluate your understanding of the topics in this module. If you score less than 70%, you should complete Module 2 - Introduction to Part 141 Pilot Schools: Part 141 Pilot Schools.
Module 2 - Introduction to Part 141 Pilot Schools: Part 141 Pilot Schools
Enabled: Adaptive Release, Statistics Tracking
Module 3 Pre-test
Use this assessment to evaluate your understanding of the topics in this module. If you score less than 70%, you should complete Module 3 - Certification and Surveillance.
Module 3 - Certification and Surveillance
Enabled: Adaptive Release, Statistics Tracking
Resources
Mastery Test
Enabled: Review
To complete the Introduction to Part 141 Pilot Schools course and update your training record, you must complete the post-course assessment if you did not achieve an overall score of 70% or more on the Module 2 and Module 3 pre-tests.
Prototype Evaluation
Module 2 Pre-Test - Gold
Enabled: Adaptive Release
Congratulations! You've passed the pre-test. No need to complete Module 2 - Introduction to Part 141 Pilot Schools.
Module 2 Pre-Test Silver
Enabled: Adaptive Release
Good Job! You've passed the pre-test. No need to complete Module 2 - Introduction to Part 141 Pilot Schools.
Module 2 Pre-Test - Bronze
Enabled: Adaptive Release
Well Done! You've passed the pre-test. No need to complete Module 2 - Introduction to Part 141 Pilot Schools.
Module 3 Pre-Test - Gold
Enabled: Adaptive Release
Congratulations! You've passed the pre-test. No need to complete Module 3 - Certification and Surveillance.
Module 3 Pre-Test - Silver
Enabled: Adaptive Release
Good Job! You've passed the pre-test. No need to complete Module 2 - Introduction to Part 141 Pilot Schools.
Module 3 Pre-Test - Bronze
Enabled: Adaptive Release
Congratulations! You've passed the pre-test. No need to complete Module 3 - Certification and Surveillance.
Course Completion
Enabled: Adaptive Release

Appendix C – Initial Report



Managing Training Content

Including Adaptive Learning Capabilities Using 21st Century Technology

Project #CMD007 Funded by AFB-540

30 March 2018

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Cover photograph c/o Edgardo Mercado

Dynamic Learning for a Dynamic Workforce:
21st Century Personalized and Adaptive Training Methods and Best Practices

Initial Report
and
Analysis of Current Federal Aviation Administration Training

General recommendations of this report regarding Adaptive Training:

1. Effective adaptive training requires sound and detailed analysis of professional learning requirements in advance; you must be clear and specific about how you want training content to be adaptive.

2. You must be highly selective when contracting an adaptive content provider to ensure a high-quality training product and to guarantee your desired results.

3. For adaptive training to be effective, you must tailor the delivery method to complement both the training content and the learner.

4. A method should be developed to allow New Hire Aviation Safety Inspectors to test out of courses if they possess proper prior knowledge of course topics.

5. A redesign of the Kirkpatrick Level 2 knowledge tests and Level 3 surveys may be needed to maximize the training effectiveness of the current training methods.

INITIAL REPORT CONTENTS

Section Title:	Page No.
1. Introduction to Adaptive Training	1
2. Managing Adaptive Training Content: An Analysis of Current Best Practices	
2.1 The Theory of Adaptive Training	5
2.2 Methods of Adaptive Training Content Delivery	15
2.3 A Successful Adaptive Training Case Study	21
3. Summary	28
4. Analysis of Current Training Methods of AFB-500 Aviation Safety Inspectors and Recommendations for Improvement	29
Appendix:	
Selecting the Right Learning Management System (LMS) or Learning Content Management System (LCMS) c/o C^2 Technologies, Inc.	

Introduction to Adaptive Training

Artificial intelligence is breathing new life into educational theory and practice. The longstanding notion that you must start a course at the beginning, follow a pre-determined, fixed order and complete every module to demonstrate mastery is no longer valid.

Recent technology can now support a more flexible and effective business approach to professional learning and development. Now, the training can flex itself to meet individual learning needs; an advantage for learners with resultant efficiencies in time and expense for training providers. Notably, today's learners can:

- demonstrate prior knowledge and thereby start in the middle of a course,
- skip unnecessary sections at any stage,
- receive extra training on subjects they find challenging,
- reveal more examples and/or tests to consolidate understanding,
- and accelerate through training objectives that they are already comfortable with and knowledgeable about.

Professional training no longer needs to be fixed in duration, residential or even classroom-based. Courses can be delivered in more convenient, on-demand, short-course packages, available anywhere, anytime. Training can be delivered on-the-job or just-in-time, and systems can automatically generate refresher modules and assessments to improve and assess retention of knowledge. This is not 'distance-learning', 'flexible-learning'[1] or 'situated-learning'[2]; this is omnipresent and reflexive learning that adapts to the needs of the learner.

Dynamic workforces therefore have myriad opportunities to deliver dynamic learning designed specifically to suit the needs of their professional community. This report provides the foundational knowledge in adaptive learning theory to start taking advantage of these opportunities. This report also seeks to offer inspiration, spotlighting the potential of this method of training delivery and training content management, by highlighting current industry best practice in adaptive training delivery.

The Academic Foundations of Adaptive Training Theory

New opportunities to improve training delivery through personalisation have evolved in tangent with recent developments in technology, but the academic foundations in support of personalised learning are not new. Indeed, the movement to individualise instruction, and to create student-centric learning environments, can be traced back decades. Research in 1977 by Cronbach and Snow, for example, investigated how 'adaptation of the learning process'

[1] For brief comparisons of these definitions, see Bates, T. (2008) https://www.tonybates.ca/2008/07/07/what-is-distance-education/ Accessed 25 Mar 2018

[2] Laouris, Y. and Eteokleous, N. (2005). 'We need an educationally relevant definition of mobile learning' (Cyprus Neuroscience and Technology Institute: 2005) Table 1

improved student performance.[3] They asserted in their study that 'content [should be] adapted to the personal characteristics and preferences of the learner, as much as possible' to improve the student experience and increase the value of instruction.[4] It has long been recognised, therefore, that tailoring instruction to suit the learner's needs and learning pace has tangible performance-enhancing results. [5] Moreover, since early experimentation with the concept of personalisation, a myriad ways have developed in which learning content and training delivery can be personalised. Each year the Horizon Report details the 'Top 6' trends in technology that will impact the future of training delivery. In 2011 it foresaw the potential of 'learning analytics' to contribute significantly towards the personalisation of a learner's experience by 2016.[6] Learning analytics and real-time data collection remained in Horizon's 'Top 6', becoming, year on year, more imminently a major contributor in educational practice. It is notable therefore, with the privilege of retrospect from a world in which analytics are now common practice, that by 2015 'Adaptive learning technologies' were featured in the Horizon 'Top 6'.[7] The prediction then was that within 4-5 years adaptive learning would be significantly impacting educational delivery. Just twelve months later that prediction had been compressed to only 1 year.[8] Recent developments in technology have, therefore, catalysed an explosion in discussions about 'Adaptive Training'.

This is not least because, whilst adaptive training is just one of many ways to implement personalised training, its pioneering use of artificial intelligence and algorithmic content control has huge potential. It was highlighted, for example, as a 'game-changer' in a future of education paper commissioned by the Bill & Melinda Gates foundation in 2015 called 'Learning to Adapt 2.0'.[9] This paper describes Adaptive Learning as a:

> 'Sophisticated, data-driven, and in some cases, nonlinear approach to instruction and remediation, adjusting to a learner's interactions and demonstrated performance level, and subsequently anticipating what types of content and resources learners need at a specific point in time to make progress'.[10]

Adaptive training therefore has the potential to deliver on promises to customise training in ways other types of personalised training do not. It aspires to prevent students from wasting effort and time whilst simultaneously increasing their engagement, thereby improving overall training effectiveness. Whilst most studies and prototypes have therefore concentrated on higher education, the promise of saving time (and therefore running costs) whilst also improving performance, makes adaptive training immensely attractive for adult learning in professional sectors.[11]

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[3] Cronbach, L. and Snow, R. (1977). Aptitudes and instructional methods: A handbook of research on interactions. (New York: Inrington Publishers).
[4] Ibid.
[5] Evidence provided in Section 2.2
[6] The Horizon Report (2011) https://library.educause.edu/resources/2011/2/2011-horizon-report Accessed 25 Mar 2018
[7] The Horizon Report (2015) https://library.educause.edu/resources/2015/2/2015-horizon-report p.44 Accessed 25 March 2018
[8] The Horizon Report (2016) https://library.educause.edu/resources/2016/2/2016-horizon-report Accessed 25 March 2018
[9] The Horizon Report (2015) p.44
[10] Tyton Partners (2017) http://tytonpartners.com/library/understanding-the-adaptive-learning-supplier-landscape/ Accessed 25 Mar 2018
[11] Educause (2017) '7 Things You Should Know about Adaptive Learning' https://library.educause.edu/resources/2017/1/7-things-you-should-know-about-adaptive-learning Accessed 25 March 2018

Adaptive training is also helping to overturn many of the negative impressions of technologically-delivered training.[12] Distance-learning, for example, has developed a reputation as a time-waster from the learner's perspective. This is because whilst distance learning may have the advantage of allowing the learner to control the time and to some degree the pace at which they learn, the courses are usually fundamentally linear and inflexible with no 'real-time' support. As a result, a struggling student is easily disenfranchised, whilst a semi-proficient student gets bored. This has led to widespread dissatisfaction and frustration amongst adult learners with distance learning packages, few of which conform to the one-size fits all philosophy behind most current course designs.[13] As Thomas Hoffman explains, dissatisfaction is 'directly related to feelings of frustration, isolation, and anxiety'.[14] By contrast, adaptive training is designed to prevent such frustrations arising. A recent EdSurge report asserts that one key advantage of adaptive training is that it 'can respond to a student's interactions in real-time by automatically providing the student with individual support.'[15] By inference, the same technology can also accelerate students that need less support, which is a clear advantage to businesses looking for efficiency savings.

This report will therefore discuss in section 2.1 how training and content can be justified as adaptive. It will further highlight the advantages that are claimed by its exponents and provide some evidence in support of its effectiveness. It will also, however, offer guidance about the limits of what adaptive training can currently achieve, its disadvantages and the limits of our appreciation of its effectiveness.

Adaptive learning also offers opportunities for training providers to re-align their own roles and change the way they contribute towards their company's professional development strategy. Adaptive training theory can be implemented across a variety of delivery methods depending on the focus of the training and the intended outcomes desired. The classroom environment can be updated to harness technological efficiencies, whilst mobile technology can enable learning outside of the classroom, and even on-the-go. The training provider's effort-balance therefore shifts towards a higher ratio of training facilitation to training provision. Multiple students can enrol on the same course with no real limit to student numbers, and students can complete their respective courses at different rates depending on their prior knowledge and other professional priorities or demands. This can increase annual training throughput without reducing the training performance standard or jeopardising concurrent professional output.

This report will therefore discuss in section 2.2 the variety of methods of adaptive training delivery, and current best practices for creating a technologically-enabled learning environment, both for the classic classroom-based student and for the liberated student.

For these reasons adaptive learning has been embraced by many higher learning institutions, companies and organisations. Notably, on account of it scale, the United States Army has adopted

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[12] For more on student dissatisfaction with distance-learning, see Power, M. & Gould-Morven, A. (2011). 'Head of gold, feet of clay; the online learning paradox', International Review of Research in Open and Distance Learning, Vol.12, No.2

[13] Hoffman, T. (2013) 'Student Dissatisfaction with Online Learning' (University of Toledo) http://www.lakeeriedigital.com/ID%20Portfolio/Writting%20Examples/Student%20Dissatisfaction%20with%20Online%20Learning.pdf Accessed 25 March 2018

[14] Hoffman, T. (2013) 'Student Dissatisfaction with Online Learning' (University of Toledo) http://www.lakeeriedigital.com/ID%20Portfolio/Writting%20Examples/Student%20Dissatisfaction%20with%20Online%20Learning.pdf Accessed 25 March 2018

[15] EdSurge (2016) 'Decoding Adaptive' (London: Pearson) https://d3e7x39d4i7wbe.cloudfront.net/static_assets/PearsonDecodingAdaptiveWeb2.pdf Accessed 25 March 2018

some adaptive learning strategies in their 2015 Army Learning Concept[16]. The United States Air Force (USAF) has also embraced adaptive learning potential in several tests and evaluations with some strong successes. According to Bill Ferster, 'Sherlock', an adaptive training course for USAF F-16 ground crew mechanics 'was able to yield the same level of competency after 20-25 hours of instruction as those who took traditional training over a four-year span'.[17]

This report will therefore highlight selected case studies in Section 2.3 that demonstrate current best practice in the implementation of adaptive training.

[16] Lt Col Lumbaca, S (2013) 'AWG Adaptive Soldier Leader Training and Education MTT Assists ALM 2015 Implementation', https://www.dvidshub.net/news/110200/awg-adaptive-soldier-leader-training-and-education-mtt-assists-alm-2015-implementation#.UnJ39_msiM5 Accessed 25 March 2018

[17] Ferster, B. (2014) *Teaching Machines: Learning from the Intersection of Education and Technology* (John Hopkins University Press) Excerpt at https://elearningindustry.com/intelligent-tutoring-systems-what-happened Accessed 25 March 2018

Managing Adaptive Training Content: An Analysis of Current Best Practices.
The Theory of Adaptive Training

What is Adaptive Training?

Whilst adaptive training is generally acknowledged as an embracement of technology to support personalisation of learning content, a refined definition is difficult. This is because there are lots of ways to 'personalise' learning, and it depends upon how you intend to make the learning experience more personal as to how you then wish to use technology to enhance that experience and make it adaptive. Different definitions from across a spectrum of academic sources and companies include the requirements for adaptive training to be:

- networked and integrated,
- 'data driven',[18]
- able to take prior knowledge into account,[19]
- able to be non-linear,[20]
- self-adjusting to the pace of the student,[21]
- able to offer interactive support.[22]

It is significant to note that a training provider need only implement one of these to promote their product as 'adaptive'. There is therefore a sharp divide between the simplest and most capable adaptive training provisions. To avoid disappointment when implementing an adaptive training solution, it is therefore wise to assess in advance how exactly you want training content to be adaptive. Bill Bilic's 2017 D2L blog 'What is Adaptive Learning' offers perhaps the best short definition of adaptivity by explaining that it is the 'adjustment of one or more characteristics of the learning environment' (as learning is taking place).[23] He further explains that in the present consumer market for adaptive products, learning content is described as adaptive if it meets one or more of the following criteria (quoted directly):

1. **Appearance/ Form:** How the learning actions—such as content, the addition of text, graphics, and/or video, etc.—are displayed to the learner. Most of today's adaptive platforms call this "content consumption" and expect knowledge to be obtained by simply reading the content.
2. **Order/ Sequencing:** How the learning actions are ordered and branched depending on the learning progress, such as pathways.
3. **Guidance towards goals or Mastery:** Actions of the system that lead a learner towards success. This allows for changes according to the most optimal learning outcomes, level of difficulty, and the learner's increasing knowledge or skill level.

This is a sound starting point for teasing out what adaptive training content really is and is not, but there is however a grey area between to what degree the adaptive system intervenes in the learning experience in 1 vs 3, or whether you retain control as a learner. To what degree is the appearance/form of content or guidance offered as optional or determined algorithmically by your actions as a learner? Bilic's definition also arguably under-represents the potential of pre-course adaptive assessment. He is not the only academic to offer a definition of 'adaptive' though. EdSurge also offer a 3-part definition that sharpens the

[18] Educause (2017) '7 Things You Should Know about Adaptive Learning'
[19] Dreambox (2018) 'What is Adaptive Learning?' http://www.dreambox.com/adaptive-learning Accessed 25 March 2018
[20] Ibid.
[21] Ibid.
[22] Ibid.
[23] Bilic, B. (2015) 'What is Adaptive Learning?' https://www.d2l.com/blog/what-is-adaptive-learning/ Accessed 25 March 2018

differences between adaptive content and adaptive assessment, and assumes that the system has greater control over content (quoted directly)[24]:

1. **Adaptive Content:** When a student gets something wrong, tools with adaptive content respond with feedback that's based on that student's specific mistake. The tools provide materials to review the relevant skill. They also break down skills into smaller pieces for students without changing the overall sequence of skills.
2. **Adaptive Assessment:** The key to understanding adaptive assessment is to remember that these tools change the questions a student sees based on his or her response to the previous question. The difficulty of questions will increase as a student answers them accurately. If the student struggles, the questions will get easier.
3. **Adaptive Sequence.** Tools with adaptive sequences have a lot going on behind the scenes. These tools are continuously collecting and analyzing student data to automatically change what a student sees next; from the order of skills a student works on, to the type of content a student receives.

This definition helps clarify further what you should expect of an adaptive course vs a classic e-learning course; in sum, greater system intervention in the learner's experience. This definition arguably however does not fully illustrate the potential of adaptive training, as it does not underscore the difference between pre-course adaptive assessment for the purpose of filtering students, and in-course adaptive assessment for the purpose of sequencing training for students. As a result, an amalgamation of both of these definitions would be more comprehensive and support stronger decision-making for adaptive training pioneers. For the purposes of this report, therefore, the three primary aspects of Adaptive Training are newly defined as:

Adaptive Appearance, Adaptive Sequencing and Adaptive Assessment.

1. **Adaptive Appearance.** This concerns the physical presentation of content to the user. This content may be presented by the adaptive system in response to the individual learner's perceived needs, such as time-sensitive hints and tips. Or this content may be enabled by the student, via 'opts-in' to available additional support, such as further examples or tests to check understanding. The key to adaptive appearance tools is that they rarely affect the content sequence. Rather, a learner can spend more time clarifying a subject in accordance with their own pace and learning preference before they progress to the next module.

2. **Adaptive Sequencing.** This concerns the physical order that the learner receives the learning content, which may or may not allow for content to be bypassed, or for a student to be re-branched temporarily, forcibly or optionally, to more foundational or additional content. It usually requires in-course testing using pre-determined questions. These questions then determine the students' next module, with additional content revealed for under-performers or the content sequence adjusted to accelerate high-achievers. Adaptive sequencing may or may not be supported by adaptive assessment.

3. **Adaptive Assessment.** This concerns pre or in-course testing that may be in of itself adaptive (i.e. the more you get right, the harder the test becomes) to determine pace,

[24] A neat graphic of this triumvirate is at Blair, K. (2016) https://www.edsurge.com/research/special-reports/adaptive-learning/definition Accessed 25 March 2018

level or, indeed, necessity of training. This may then be followed by a course including adaptive sequencing or adaptive appearance to match the learner's progress or learning rate. Adaptive assessment may consider not only the scores achieved in testing but the speed of response to determine the student's onward pathway.

By these definitions, there can be great variety in the degree to which training is adaptive. To illustrate this variety are three examples below:

EXAMPLE 1 – COURSE A

Students taking Course A all start the course at Module 1. As they progress through the modules they can choose whether they click on extra examples, videos, mini-quizzes etc to test their understanding. All students complete the course in the same order but depending on whether they take advantage of all adaptive content, may finish at different rates. An end of course test determines their end of course grade.

EXAMPLE 2 – COURSE B

Students taking Course B will all start at Module 1, but depending on how successfully they complete an end of module test, some will immediately progress to Module 2, whilst others will be re-directed to Module 1.1 for additional instruction, examples and a second end of module test. Successful students will then re-join the course at Module 2, unsuccessful students will be redirected to Module 1.2 for additional examples and a third end of module test. Successful students re-join the course at Module 2 whilst unsuccessful students will be flagged for intervention by a training facilitator.

EXAMPLE 3 – COURSE C

Students taking Course C all sit a pre-course exam with foundational, intermediate and advanced questions. Students are only given the intermediate questions if they achieve 80% or more correct answers on the foundational questions. Likewise, students only receive the advanced questions if they achieve 80% or more on the intermediate questions.

Students that only complete foundational questions and receive less than 80%, will start Course C at a foundational level. Students that complete the foundational and intermediate questions but achieve less than 80% on the intermediate questions start Course C at an intermediate level. Students that complete all questions but achieve less than 80% on the advanced questions start Course C at an advanced level. Students that achieve more than 80% on all three test levels are not required to complete Course C, but are sent certification of prior knowledge and refresher material on the subjects they scored the least in.

Summary

Course A is an example of Appearance adaptation, in that the learner has control over how the information is physically presented. They can choose whether they prefer visual learning, audio learning or kinaesthetic learning, by enabling features of the course that other learners have the option of bypassing. The course does not however rely on any algorithms to support the learner; rather every learner will be presented with the same options and it is at the learner's discretion to choose which options best suit their learning style and needs. This is technologically the simplest form of adaptive learning content. It is also the one which requires the least interaction between the system and the learner, and may be familiar as a method currently employed by many distance-learning providers.

Course B is an example of sequencing adaptation. Using algorithms, the system can change the pathway the student takes to achieve all the course objectives. A student with prior learning or understanding will take the least steps to complete the course, whilst a student with no prior learning or understanding may utilise the full functionality of the course and

experience every step. This enables the system to control the pace of learning, accelerating the learning experience for some whilst adjusting to provide more time and more learning content for others. This demonstrates adaptive learning content, but not adaptive assessment, as the questions posed to the students are all identical. Student proficiency at these set questions determines whether they progress immediately or divert temporarily.
Course C is an example of pre-course adaptive assessment, to filter students to appropriate learning content (which may or may not be adaptive in appearance or sequence). In this example all students are asked foundation-level questions, with those achieving over a certain score given access to intermediate questions. Success above a prescribed score at the intermediate level provides access to more advanced questions. In this manner all students are filtered to the appropriate course level for their starting proficiency, or simply certified and offered a refresher training package that covers just the small gaps in their knowledge.
These three brief and simple examples demonstrate that training content can be designed to be adaptive in a variety of ways, with some ways more technologically complex than others. When designing, or commissioning the design of, an adaptive training product, you must therefore be clear and specific about how you want training content to be adaptive. For example:

- Do you want to conduct adaptive assessment to filter students to different non-adaptive courses at different levels?
- Or do you want to offer an adaptive content course with adaptive sequencing but without adaptive assessment?
- Or do you want both pre-course and in-course adaptive assessment and adaptive content and adaptive sequencing throughout?!

To ensure that you request the right type and degree of adaptivity, you must conduct sound and detailed analysis of professional learning requirements to determine which method or combination of methods to adapt training will best suit the learners' needs and the training objectives. To avoid disappointment, training providers should also heed cautions about the many different ways content may currently described as adaptive. If you are looking for something relatively simple, adaptive appearance, sequencing and assessment combined may be overkill. Vice versa, if you are looking for something sophisticated you will need bespoke support to create it, as many of the off-the-shelf solutions will not meet your requirements and the results will be disappointing.

The Advantages of Adaptive Training

There are many advantages of adaptive training according to current industry providers and academics in the field. These advantages include:

- **Improved student performance.** In a study by McGraw Hill Education, 84% of students using adaptive technology indicated a moderate to major improvement in grades.[25] Knewton has also conducted multiple academic studies into the success of adaptive training, including one that canvassed 288,000 college students studying science related courses 2013-14. This particular study showed a modest 4% average

[25] McGraw Hill Education, (2015-2016) 'Digital Study Trends in Higher Ed Survey' https://www.mheducation.com/highered/platforms.html Accessed 25 March 2018

grade improvement using adaptive assessment strategies only.[26] Another study detailed in the Horizon Report 2017 highlights how use of adaptive learning on two undergraduate courses resulted in an impressive 18% increase in student success, and increased retention of students on both courses.[27]

- **Provide truly individualised learning.**[28] As EduCause concluded following their own research, adaptive training is 'great for self-paced of competency-based courses'.[29] This suggests that it would lend itself well to a professional workforce seeking to promote personal development and encourage competency-based lifelong learning.

- **Increased workforce productivity.** By delivering courses that adapt to the learner and can be accessed anywhere, anytime, there is less of a requirement for residential training courses. This can save significant costs, not only by reducing the time training personnel spend delivering courses, but also second-order costs of students' travel, accommodation and per diem, and other hidden costs borne of time-out-of-the-office. The hidden costs of residential training include over-time expenses for personnel brought in to cover for absent personnel, the productivity costs of training-caused absenteeism and the increased stress and fatigue caused by compressing personnel's time to complete operational currency and competency requirements before and after the course.

- **Reduced disruption for recurrent and refresher training.** Every business has recurrent and refresher training that displaces personnel during the normal working day and requires other personnel to cover, or even requires that over-time be paid to the individual to receive training outside of normal duty hours. M-learning courses enable this training to be delivered on a modular and tracked basis, enabling 4 hours of training to be delivered in small, bite-size portions over a longer period. The advantage of this is that training can be more easily integrated into the normal working day. This reduces the pressure on frontline management to balance disruptive recurrent training schedules with operational output. Adaptive assessment would further enable personnel to demonstrate proficiency and prior knowledge before taking the training, and therefore certify without disrupting scheduling or productivity at all (except for the time required to undertake the assessment).

- **Real-time Feedback.** Adaptive learning uses technology to adapt to the users learning style and provide training via e-learning or m-learning platforms anytime, anywhere. It can offer assistance to the learner based on speed of response or accuracy of inputs without any intervention, and therefore offers the learner instant real-time feedback on their performance and onward learning journey. The systems

[26] Knewton (2017) https://www.knewton.com/results/ No longer accessible, but verified by this secondary source Gupta P. (2017) EdTechReview: Adaptive Learning in Education, http://edtechreview.in/trends-insights/trends/2802-adaptive-learning-in-education Accessed 25 March 2018
[27] Horizon Report (2017) https://library.educause.edu/~/media/files/library/2017/2/2017horizonreporthe.pdf Accessed 25 March 2018
[28] Elsevier (2018) https://evolve.elsevier.com/education/adaptive-learning/ Accessed 25 March 2018
[29] '7 Things You Should Know about Adaptive Learning' (2017) (Abstract)

consequently usually store massive amounts of data in the cloud about learners, enabling artificial intelligence to analyse trends and determine the next step in training. The training provider can also take advantage of this easily accessible cloud-based data to receive real-time feedback of students' progress, test results or module completion. As Nedungadi and Raman highlighted in 2012, adaptive training can track all learner inputs, including 'answers, hints requested, time, [and] tutorials viewed'.[30] As a result this data can be used to evaluate the course's effectiveness; if many students require extra assistance on the same topic, or fail the same tests, then the training itself can be reviewed and updated in real-time. Data analysis can therefore help identify trends to improve the training content itself. It is always recommended to test and evaluate a prototype course on a select group of students before rolling out a course wholesale, so that this opportunity to review the course before roll-out can be undertaken.

- **Customized classroom-based training.** Adaptive training can be used in a number of ways to enhance the classic classroom experience:
    - An adaptive assessment of students' prior knowledge of training objectives may enable some of the classroom lessons to be removed, thereby shortening the course and reducing unnecessary costs of accommodation and per diem. Or, the same data may enable a staggered arrival, with students that require the whole course arriving on day 1, and students that demonstrated proficiency or prior knowledge joining on day 2 or 3 etc, with similar cost-savings.
    - As adaptive training is cloud-based, adaptive m-learning can be brought into the classroom. One example would be to set a collaborative task that requires progression through m-learning training content (that adapts in appearance and sequence to each learner) as students work towards a common goal in small teams. The students might each have access to different information, that they need to understand and share to solve a problem collaboratively.
    - Gamification of End of Lesson Tests can not only engage students by offering a real-time in-classroom summary quiz that rewards them for speed and accuracy of responses, but also records their results for the training provider. This enables formative rather than summative assessment of individual students. Furthermore, this data can be used to assess which lessons are more or less effective, with a view to improving residential training delivery.

- **Higher student engagement and retention.** In the McGraw Hill Education study previously referenced, 87% of students enjoyed the learning experience more. This

[30] Nedungadi, P. and Raman, R. (August 2012) 'A New Approach to Personalization: Integrating e-learning and m-learning', Educational Technology Research and Development, Vol. 60, No. 4, p.660

has secondary advantages of retaining more students, as also found in the Horizon 2017 report.[31]

- **Supports changes in the role of training personnel.**[32] It is axiomatic that if the student is gaining more control over their own learning, the role of the training personnel will start to change too. Indeed, adaptive training requires a variety of roles to be fulfilled by current training personnel:

    - **Stage 1: Change Ambassador.** Training personnel will need to be consulted to determine the learning requirements of their professional community, determine which courses would benefit from the use of adaptive learning theory, and determine to what extent training would be usefully adaptive (appearance/ sequencing/ assessment).

    - **Stage 2: Consultant.** Once the training objectives and course content to be made adaptive have been identified, training personnel will be working closely with the contracted training developer to create the courses.

    - **Stage 3: Evaluator.** Once a prototype is created, training personnel will need to test and evaluate it with a small group of students. If changes are required, these will be made at the recommendation of the training personnel, including feedback from students.

    - **Stage 4: Facilitator.** Once the course is finalised and endorsed, training personnel become facilitators. They will be liaising with students to ensure all students are engaged, and they will be managing student participation. They will, for example, be creating accounts, answering questions about how to operate the course, liaising with students that are slow to complete the course and supporting students that reach an impasse in training.

A clear advantage of adaptive training is that once it is set-up and established, the role of the training personnel becomes that of facilitator. Their daily schedule will be less about fixed training time-slots and course delivery, and more about training facilitation. This will ultimately free up capacity in the training system to increase student numbers and thereby reduce training delays. Training staff must be comfortable with the changes that adaptive training will bring to their future roles for implementation to be successful.
It must be noted however that many of the advantages listed on provider websites are unsubstantiated, and this report only contains those for which evidence was provided. The limited data available also warrants the following three cautions:

1. Most of the recent studies cited draw evidence from studies undertaken at High School or College Level and therefore may have limited validity for substantiating implementation in the adult learning sector.
2. Most of the studies cited use data from courses that deliver maths or science subjects which can be more easily adaptively assessed or delivered using adaptive appearance

[31] Horizon Report (2017) https://library.educause.edu/~/media/files/library/2017/2/2017horizonreporthe.pdf
[32] '7 Things You Should Know about Adaptive Learning' (2017) https://library.educause.edu/resources/2017/1/7-things-you-should-know-about-adaptive-learning Abstract

and sequencing methodologies. There is little evidence to support adaptive training in less technical subjects, although this research is beginning to happen. The University of Georgia is developing an adaptive English course, for example.

3. There is limited availability of data for studies in professional environments, even though many companies are marketing their adaptive training content to businesses. This lack of transparency about efficacy in the corporate sector is unhelpful for businesses hoping to make evidence-based decisions about training provision.

This report therefore recommends that following a sound and detailed analysis of how adaptive training could serve learner needs, it would be wise to endorse relevant prototype development and validation before large investments into adaptive training delivery are made.

Disadvantages of Adaptive Training

There are also some recognised disadvantages to adaptive training that are worthy of consideration:

- **It can be costly to implement.** Each course needs detailed analysis to convert it into an adaptive course, and potentially additional time will need to be spent to ensure it is compatible for a different software platform as well. This requires money to be invested upfront – both to fund the hours required to employ both current personnel to be consulted and a contracted training provider to deliver the newly adaptive courses (including prototype development, test and evaluation). Once a course is running, however there are cost-benefits associated (primary, secondary and hidden), as detailed in the advantages section.

- **Time-consuming to implement.** Adaptive training, whilst a relatively new method of training delivery, is also well known to be labour intensive to establish. As Karmeshu et al. assert, 'personalized learning environments require complex instructional design'[33] and this requires careful analysis and application that demands time and attention. This additional workload may not be received well by current training staff if other demands are not reduced to enable this analysis to take place.

- **Overwhelming for training staff, if insufficiently trained.** Adaptive courses tend to generate huge amounts of data on students, and therefore training personnel must be very careful to filter what data they need vs what data would be superfluous and overwhelming.[34] It is important that the training personnel that will be delivering the courses are embraced during the development, testing and evaluation stages to ensure they are comfortable with the technology they are managing.

- **Change management.** The advantages of adaptive training are evident, but if there is not a robust change management strategy to support the conversion of eligible

[33] Karmeshu, Raman.R and Nedungadi, P. (August 2012), 'Modelling diffusion of a personalized learning framework', *Educational Technology Research and Development*, Vol. 60, No. 4. p.586

[34] Freda, B. (26 August 2016) 'Clearing the Hurdles to Adaptive Learning' (University Business) https://www.universitybusiness.com/article/adaptive-learning-clearing-hurdles-higher-ed Accessed 25 March 2018

courses, adaptive training will not be well received by students or staff. As Karmeshu et al caution – the 'critical factor in the success of the adoption of personalised learning paradigms is the in-service [teacher-training] program'.[35] Personnel need support during the transition. This makes the selection of a supportive and forward-leaning contracted training provider imperative. It also necessitates empathetic management and ambassadors of change at leadership levels.

- **Lack of vendor transparency.** It may be challenging to choose a reliable training provider or platform as many vendors of adaptive products lack transparency about the algorithms they use, or do not offer evidence of quantifiable efficacy results.

- **New Challenges in Student management.** It is difficult to implement deadlines for students to complete training. It is also difficult to predict how a learner will relate to the content; as Karmeshu et al caution, 'it is important to be realistic in terms of the learner's ability to evolve as a competent, adaptive, goal-oriented and motivated learner'.[36] There may need to be more interaction between training personnel and frontline managers to supervise student's engagement with mandatory training. There will need to be proactive engagement with students by training personnel throughout the training experience.

- **Content Limitations.** Whilst adaptive training has proven effective for entry-level courses, it does not tend to enable higher level critical analysis, as would normally be determined by more detailed written responses and face-to-face discussion. These interactions are currently outside the capability of artificial intelligence to assess accurately. It should be noted at this stage that fairly recent studies have also been somewhat inconclusive about the effectiveness of adaptive learning.[37] This is not to say that they are ineffective, but if you are pursuing a tangible increase in grades for an existing course at a lower cost, adaptive training has only occasionally proven a rewarding investment of time and money. Moreover, these have been heavily College-based rather than professionally-based studies.

Despite these disadvantages, adaptive training evidently has clear potential for supporting professional learning communities. The current corporate training model is currently tied to residential/classroom delivery at one end of the spectrum, and 'distance-learning' at the other. Adaptive learning may therefore prove to be a suitable cost-saving and rewarding method of training delivery that bridges this out-dated divide. If the desired result is not an increase in grades, as has been the focus of most studies into adaptive training, but rather the pursuit of a more efficient and flexible method of content delivery and management, then adaptive training offers some very promising, but as yet largely untested, potential for professional development courses.
It is perhaps worth noting at this juncture that Rogers' compelling 'innovation diffusion theory' suggests that not until 10-25% of people in a system adopt a new innovation will the

[35] Karmeshu, Raman.R and Nedungadi, P. (August 2012), 'Modelling diffusion of a personalized learning framework', Educational Technology Research and Development, Vol. 60, No. 4, p.596
[36] Ibid. p.587
[37] Straumsheim, C. (2016) 'Learning to Adapt', (Inside Higher Ed) https://www.insidehighered.com/news/2016/06/23/study-finds-inconclusive-results-about-efficacy-adaptive-learning Accessed 25 Mar 2018

innovation diffuse throughout that system.[38] This suggests that without a robust and well-considered change management program to accompany the roll out of adaptive training content, it will not necessarily be valued as expected by the innovative minority. Importantly, it is not clear from recent studies whether attempts to implement adaptive training at Colleges were accompanied by the appropriate change management strategy needed to assure innovative success. It is revealing that in one of the largest U.S. based College-level studies of Adaptive training, less than half of faculty staff intended to keep using the software after completion of the study![39] Key to ensuring that adaptive training is well received is, therefore, the simultaneous development of an implementation plan that recruits ambassadors of change (training personnel and leadership) at the earliest stage to accelerate the accumulation of the critical 10-25% system-wide adopters.

[38] Rogers, E. (1995) Diffusion of Innovations (The Free Press, New York) p.12
[39] Straumsheim, C. (2016) 'Learning to Adapt', (Inside Higher Ed)

Managing Adaptive Training Content: An Analysis of Current Best Practices.
Methods of Adaptive Training Content Delivery

Noting that there are many different ways to create adaptive course content and assessment, it is perhaps axiomatic that there are many different ways to deliver adaptive content and assessment. This report will focus on the key differences between implementing adaptive training in the classic classroom using technology, as compared to purely technological delivery outside the classroom. It will also highlight recognised best practices.

Adaptive Training Delivery in the Classroom: Technology-Supported

Adaptive training has been considered best practice in the physical classroom for a long time. The idea that more support will be provided to those learners that need extra time, explanation and attention, whilst more challenging content will be provided to those learners that demonstrate above average aptitude and understanding, has long been a tenet of high-quality teaching. The widespread adoption of this method of adaptive training delivery is in part because it can be applied to almost any subject and any sized class. Some establishments take extra measures to tailor their courses to student knowledge, ability and learning styles. For example, creating different 'sets' of learners according to grouped abilities is also adaptive delivery in action; the higher set will cover more material in the same time.

With the development of educational technology in recent years, there have however been numerous revisions to the practice of applying adaptive theory in the classroom. A number of these technology-supported delivery methods can be considered current best practice:

- **A blended learning environment:** Clifford Maxwell of Blended Learning Universe explains that 'blended learning is any formal education program in which a student learns at least in part through online learning, with some element of student control over time, place, path, and/or pace.'[40] This thereby enables the application of adaptive learning concepts with the assistance of online learning platforms to complement and supplement physical classroom objectives.

- **Gamification:** This involves 'using game design elements in non-game applications to make them more fun and engaging'.[41] In the classroom this strategy to engage leaners works for all ages and works by motivating students to learn. It does so by giving them rewards, creating 'loss aversion' (not wanting to lose something), fostering competition or providing instant feedback.[42] Platforms likes Kahoot.it and Quizizz, for example, allow you to run live quizzes in the classroom, in which speed of response and accuracy are rewarded and the fastest most accurate student is awarded an in-game trophy. This can be used to check-understanding, encourage self-analysis, instantly determine areas for improvement and also help direct the next step in training for the instructional staff: for instance - does the class need to revise this subject before moving on? This is adaptive sequencing in action in a live classroom scenario.

- **Cloud-based learning:** Using blended learning principles, a vast amount of data can be gathered about individual learners and used for analytics to determine progress,

[40] Maxwell, C. (2016) 'What Blended Learning is – and isn't' (Blended Learning Universe) https://www.blendedlearning.org/what-blended-learning-is-and-isnt/ Accessed 25 March 2018
[41] Laja, P. (2012) 'Gamification for Better Results' (Kissmetrics) https://blog.kissmetrics.com/gamification-for-better-results/ Accessed 25 March 2018
[42] Ibid.

understanding and completion of training objectives. All data is uploaded to the cloud via mobile data or wifi connections, making it instantly available to the training facilitator. A student spending a lot of time on course content, maximising all pathways, and still under-performing can be flagged for intervention and additional support. Vice versa, a student that spends little time on course content, minimising the pathway to the mastery but achieving excellent scores can be accelerated onto more advanced levels (or in the corporate environment, returned to productive service).

N.B. Blended learning, gamification and cloud-based learning can all also be implemented as elements of a fully technologically-delivered adaptive training course.

Technology-Enabled Adaptive Training Delivery

All three parts of this report's definition of adaptive training: Appearance, Sequence and Assessment are more easily delivered by software designed to track, analyse and adjust training content as the student learns. The key advantage of delivering adaptive training using technological means alone is that personalisation is achieved without facilitator intervention. For an operational course, technology therefore reduces the time and effort required to run training. Moreover, updates to courses can be rolled out as new version that can be broadcast as a mandatory update to all students. A principle disadvantage of technological delivery, however, is the cost of initial implementation, both in terms of financial investment and the time required to determine and create all the different pathways students may require.

There are a variety of technological means of delivering adaptive training. These usually include one of the following principles:

- **Microlearning**: Microlearning comprises small units of learning material delivered on mobile devices that usually last no more than 5 minutes. Entire courses can be broken down into tiny modules that can be accessed anywhere and at any time. These modules can take advantage of adaptive appearance, sequencing and assessment, and are hugely versatile.

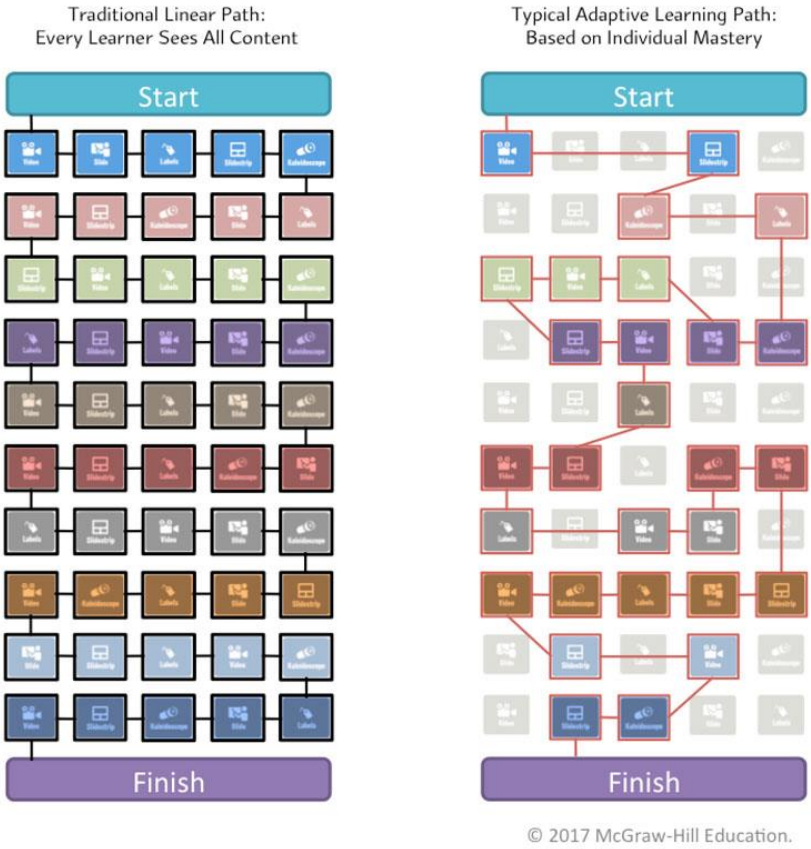
- **Intelligent Tutoring Systems (ITSs):** Bill Ferster explains that 'A typical ITS will contain a number of conceptual components, or models, that interact with one another. The content model contains a web-like mapping of the content to be learned, defining the prerequisites and dependencies between the content elements. The student model is unique to each learner and works in parallel with the content model to record what the student does, and does not yet understand. Finally, there is a method of delivering the instruction to the learner, known as the pedagogical model'.[43] Essentially, ITSs embody adaptive training, with all adaptive strategies bundled into a single-access course to deliver pre-determined training objectives.

- **Asynchronous Learning:** According to researchers at the University of Michigan**,** 'Asynchronous Learning is also called Location Independent Learning, and is opposite to synchronous learning where students learn at the same time by activities such as attending a lecture or laboratory. The asynchronous learning environment provides students with teaching materials and tools for registration, instruction, and discussion. Asynchronous learning involves the ability to maintain communication

[43] Ferster, B. (2017) 'Intelligent Tutoring Systems: What Happened?' (eLearning Industry) https://elearningindustry.com/intelligent-tutoring-systems-what-happened Accessed 25 March 2018

without having to meet at the same place at the same time.'[44] The main advantage of asynchronous learning is that the student can learn anywhere, at any time, and therefore, by incorporating adaptive theory, a student can also set their own pace of learning. A common software platform that will automatically update in real-time is required to enable this type of delivery.

- **Mastery-Based Learning:** As Zach Posner of McGraw Hill Education explains, 'mastery-based instruction places the emphasis on mastery rather than seat-time, which generally leads to higher proficiency and engagement levels for all learners'[45] This is similar in some ways to the principles of ITS, but Posner uses the following graphic to demonstrate the main philosophy of mastery-based learning is an efficiency-based approach to learning.



Choices regarding the method of technological delivery

Once you have determined the best adaptive practices for technological delivery to suit your training objectives and learning community you must choose which Learning Management System (LMS) or Learning Content Management System (LCMS) will be best suited to host your course. These platforms notably have different interfaces depending on the course

[44] Varde N. and Fogler, H. (2000) 'Asynchronous Learning' (University of Michigan) http://umich.edu/~elements/asyLearn/learning.htm Accessed 25 March 2018
[45] Posner, Z. (2017) 'What is Adaptive Learning Anyway?' https://www.mheducation.com/ideas/what-is-adaptive-learning.html Accessed 25 March 2018

purpose and learning demographic, and different implementation and running costs. The main LMS/LCMS categories are:

- Corporate vs. Academic
- Free (Opensource) vs. Commercial (Proprietary)
- Cloud (Web-based/SAAS) vs. Installed (Self-Hosted)
- Integrated vs. Single-Purpose
- Synchronous vs. Self-Paced
- Closed (off the shelf) vs Open (bespoke) vs Hybrid (somewhere in between)

There are therefore a huge variety of LMS and LCMS platforms available, with varying strengths and weaknesses. For the corporate market, some are more popular with users than others. In a recent study, Docebo and TalentLMS, for example, achieved remarkable 100% and 99% corporate learner satisfaction levels respectively.[46] All top performing LMS in the same comparison study are compatible with HTML5 and Native iOS and Android Apps making them widely accessible; this means they can be accessed from a PC or from your Android phone or tablet. This is important, as adaptive learning is most effective if it is freely available anywhere, anytime.

Some LMS and LCMS, however, can only be described as adaptive platforms if they are coupled with an add-on software package. Blackboard Learn for example requires the add-on 'IAD Learning' to enable adaptive features. As the IAD Learning website explains, 'IADLearning determines the students' behavioural patterns and their underlining learning styles. Combining the identified patterns with historical data, student profile information and student tests results, IADLearning establishes an **individual dynamic pathway through your content** for each of your Learning Management System (LMS) users'.[47] This essentially promises adaptive appearance and sequencing, but not adaptive assessment. Therefore, if you choose to use Blackboard Learn you are limited to purchasing this add-on, which depending on your requirements, may or may not meet all your needs.

Testing and evaluating adaptive training products must therefore take into consideration the differences between available platforms. It is recommended that, should a prototype product be commissioned, a thorough analysis of the learner requirements be conducted to ensure that the most suitable training platform (LMS/LCMS) is selected for the type of adaptive training under evaluation. This analysis can be undertaken by the contracted training provider, but it needs close engagement and thoughtful analytics by stakeholders from the contracting company to ensure that the most appropriate platform is selected.

A detailed and comprehensive comparison of selected LMS and LCMS platforms provided by C² Technologies is an Appendix to this initial report.

Current Best Practices in Adaptive Training Delivery

There are a number of best practices currently available for adaptive training delivery that are particularly well suited to corporate environments. These are:

- Microlearning,
- Asynchronous Training (On-the-job or just-in-time or on-demand training)
- Adaptive testing (Pre-Employment testing) and

[46] Finances Online (2018) https://learning-management-system.financesonline.com/c/corporate-lms Accessed 25 March 2018

[47] IAD Learning (2018) 'What is IAD Learning' https://www.iadlearning.com/ Accessed 25 March 2018

- Multiple Methods of Delivery

These are discussed in more detail below:

Best Practice: Adaptive Micro-learning

If a professional environment has a high requirement for currency training, recurrent training or refresher training, but also has a dynamic workforce that is rarely all present to receive a physical briefing, microlearning may be an appealing technologically-dependent solution. Microlearning comprises small units of learning material delivered on mobile devices that usually last no more than 5 minutes. These would allow for mandatory briefings or refresher training to be pushed to employees, tracked for completion, and recorded for audit purposes. Should the micro-learning units be combined with adaptive appearance, sequencing and/or assessment the potential for improving workforce access to learning increases further. This is because an adaptive assessment could be sent out in advance of refresher training to determine the requirement of the learner to undertake the microlearning refresher module. If retention of knowledge from original training is sufficiently high, the learner does not need to waste time completing the refresher training. If new material is being broadcast within refresher training, the micro-learning may be adaptive in appearance or sequence to enable experienced personnel to jump straight to the new material, bypassing the revision material. A key advantage of micro-learning is that a 25-minute briefing can be easily spread over a week in more manageable micro-instalments of 5 minutes per day, or avoided completely if not necessary, without management losing oversight of who has and has not received the training. This will improve workforce capacity and give personnel more control over their mandatory learning packages.

Best Practice: Adaptive Training for On-the-Job-Training, or Training-on-Demand

If delivered outside of the traditional classroom, adaptive training has great potential to support personnel undertaking on-the-job training or training-on-demand. This is because the employer can control which courses the student has access to, but once enrolled the student is in control of pace, extent and timing of training for upcoming roles or responsibilities. An individual that has worked with a company for 6 years but received training for a role on entry that they have not performed since can undergo refresher training adapted to their personal retention of knowledge. This approach to adaptive training may also negate the need for comprehensive initial entry training courses because, in theory, employees can undertake training flexibly according to their own skills and experience as their careers progress.

Best Practice: Pre-Employment Adaptive Testing

One key advantage of m-learning or personal computing-based adaptive assessment is that candidates for a technical position can be screened before interview for skills and suitability, or an accepted candidate can be given pre-employment adaptive testing to determine what introductory courses, if any, are required on day 1.

Best Practice: Multiple Methods of Training Delivery

Every learner has individual learning needs. These may be related to:

- learner conditions such as Dyslexia or Dyscalculia
- learner preferences (visual, audial, kinaesthetic)
- learner circumstances (mental health, time constraints, professional schedule and life-tempo)
- learner skillsets (prior knowledge, prior experience or digital literacy/illiteracy).

No single method of training delivery is necessarily right for every learner. Best practice for adaptive learning is therefore to offer the same training objectives in a variety of adaptive delivery methods to give the learner flexibility to choose the method that best suits their personal requirements. The benefit of multiple learning platforms for the same learning content is that all students, whatever their personal learning needs, have access to high-quality, personalised, adaptive training, to meet their professional training needs.

Managing Adaptive Training Content: An Analysis of Current Best Practices. A Successful Adaptive Training Case Study

Technology-Enhanced Learning Environments to Solve Performance Problems: A Case of a Korean Company

The following case presents how the use of learning environments enhanced by technology can be used to improve competence development in employees. Challenges in a day to day working environment can present opportunities to improve performance and learning. Technology such as Electronic Performance Support (EPSS), Knowledge Management Systems (KMS), e-learning and online Community of Practice (CoP) are portrayed in this case and how they were used to improve training and development.

The Rand report by Karoly and Panis (2004) specifically emphasized that in order to meet the demands of the 21st century, a workforce requires knowledge workers who are able to solve quickly-changing real world problems. Wolfe (2007) wrote that over 80 percent of learning occurs during practice. Therefore, this case illustrates how the use of e-learning and mobile devices can improve job performance and competencies in employees.

New technologies (e.g., computers, wired and wireless Internet, PDAs, and smart phones) enable workplace learning to be placed and facilitated in integrated technology-enhanced learning environments (e.g., EPSS − Electronic Performance Support Systems, KMS − Knowledge Management Systems, e-learning, and CoP systems). Namely, technology-enhanced learning environments make the components of workplace learning not divergent but convergent learning system.

According to Hannafin and Land (1997) they "characterize technology-enhanced learning environments (TELE)" as follows:

Figure 1. Technology enhanced learning environments (TELEs) in the workplace – (Reproduced from page 38, TechTrends, January/February 2011)

On page 168 of the *Instructional Science*, 25(3), 167-202, Hannafin and Land (1997) wrote (referring to technology enhanced learning environments):
They provide interactive, complimentary activities that enable individuals to address unique learning interests and needs, study multiple levels of complexity, and deepen

understanding. They establish conditions that enrich thinking and learning and use technology to enable flexible methods through which the processes can be supported.

The following case illustrates how technology-enhanced learning environments integrate themselves and how they bridge one type of learning with other types of learning in the workplace as a composition of CoPs. This example exemplifies how an insurance Korean company promotes technology-enhanced learning environments by re-designing how people learn using online Community of Practice or CoP:

Description of the company for this case study

- This is one of the largest insurance providers in Korea
- The company has approximately 30,000 employees with more than 20,000 sales associates. There are close to 1,500 branch offices divided into several local sales districts.
- During 1998 the company had serious financial problems that led to a merger with a large conglomerate.
- Recruiting and retaining skilled sales associates made it difficult, besides competition and regulations, making training needed so managers and sales associates can develop advanced knowledge and skills.
- As a solution, executives are emphasizing the importance of sustaining their talented sales associates and improving their performance by means of enhancing their expertise.

Performance Problems Identified

This led to a series of performance problems including:

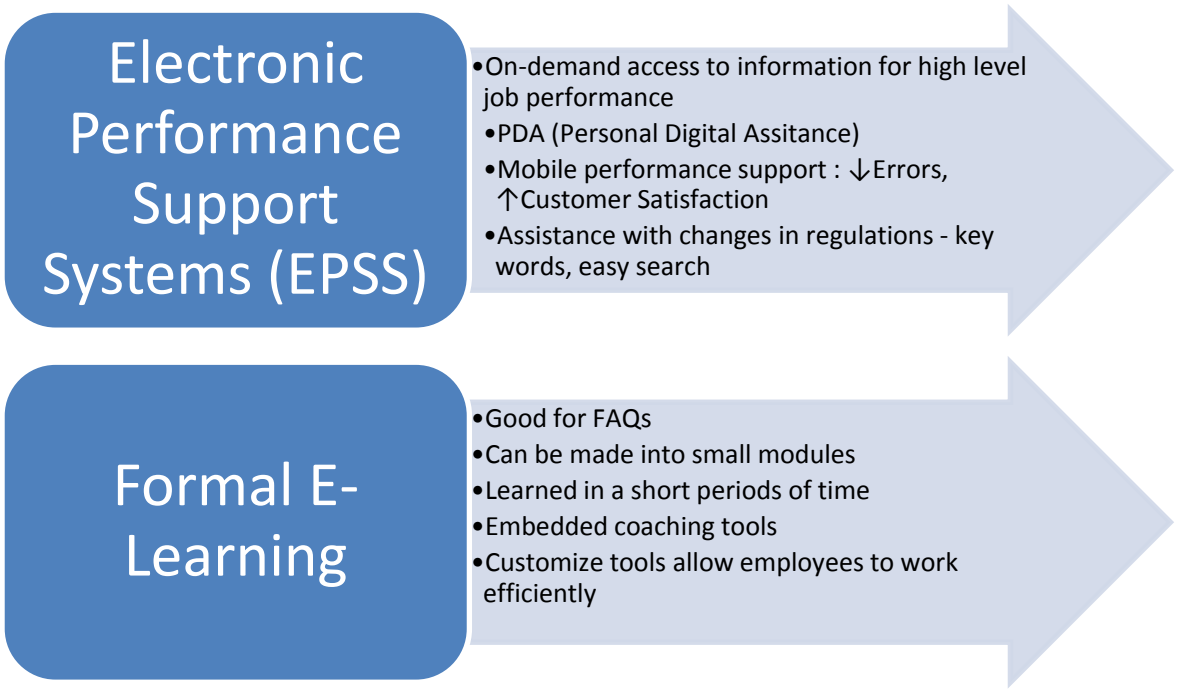
-High turnover
- Lack of effective communications among sales associates
- Difficulty to keep up with new regulations
- Questionable effectiveness in spite increased training
- Little time for increased knowledge and skills due to high number of meetings at their sales branches
- Slow communication to disseminate information from headquarters when new regulations, rules, policies and strategies occurred to the branches
- Internal difficulties to consult with an expert
- Sales associates had problems finding meaningful information about plans and regulations

Solutions for performance problems sought by the company

A few solutions were suggested:

- The company wanted to ensure that sales associates had appropriate knowledge of new plans and regulations
- They also wanted to ensure that all employees from each branch were informed of new information coming from headquarters within 24 hours after it was dispatched
- Lastly, they wanted to provide a performance support system that sales associates could access as needed regardless of where they were, including client locations.

The case also illustrated examples of Technology-Enhanced Learning Environments utilizing Electronic Performance Support Systems (EPSS) and formal e-learning, and how different tools could be used. Find a diagram below of how electronic tools could be integrated in each system:



Electronic Performance Support System (EPSS) is an electronic system that provides integrated, on-demand access to information, advice, learning, and tools to enable a high level of job performance (Hudzina, Rowley, & Wager, 1996; Stevens & Stevens, 1996). Simply stated, EPSS is a network of online and offline job resources (Kim, 2011).

In the insurance company above mentioned, an "EPSS was developed and integrated with Personal Digital Assistants (PDAs) because sales associates usually work out of the office and in most situations cannot access information using a wired network. A mobile performance support environment enhanced by PDA-based EPSS is expected to enable sales personnel to reduce information errors and result in increased customer satisfaction" (Kim, 2011).

New plans and regulations made it difficult for sales personnel to memorize all relevant details. The EPSS provides information to sales associates when needed, regardless of location. For example, using keywords or task categories, a sales associate can search for sales information about bank assurance in the repository of the EPSS while sitting in a client's office (Kims, 2011).

The article explains how small modular content material should be considered for formal learning or for electronic learning. The idea behind this is for the information to be accessible if needed and learned in a short period of time. An example of this could be frequently asked questions. "Learning materials in the EPSS can be integrated with formal training materials. After providing formal online training, materials were transferred into the repository in the PDA-based EPSS" (Kim, 2011).

A suggestion could be to consider embedded or implanted tools that could be helpful. This will allow for employees to search quickly a word and/or identify a drawing that once selected could offer instructional tools or an instruction wizard. This will provide for quick, up-to-date information on the spot without having to depend of contacting somebody within the company to get the information, thus improving efficiency and more control in the hands of the employee.

Knowledge management system (KMS)

Companies have a lot of information that they must manage and in doing so, they also benefit employees. Once employees have been trained, the question is what do companies do with all the information they know or learned? How does this benefit the company or the

employees? How do companies manage knowledge? "Considering that knowledgeable workers pursue opportunities to promote their careers and improve their knowledge, it is understandable that they move from one organization to another. For that reason, it is critical that an organization capture, codify, and distribute their employees' tacit knowledge so as to make such valuable knowledge available to all who need it" (Lien, Hung, & McLean, 2007; Rosenberg, 2007).

In the article sales associates looked for support from their managers to gain important knowledge. "The Community of Practice (CoP) system integrates with Knowledge Management Systems (KMS) and can serve to connect experts and novices who share areas of interest. Selected knowledge workers, usually top-ranked sales personnel, and a community leader were assigned to a CoP" (Kim, 2011).

Knowledge Management could integrate collaboration among peers, other company members, etc. This could lead to sharing general or specific information.

E-learning based on reusable learning objects

Boskic, 2003; Robson, Collier, & Muramatsu, 2005 found the following:

> The training management system is a software package that organizes, delivers, and tracks all types of training resources through a central interface over a network. E-learning is a key component of the training management system, delivering training opportunities and just-in-time learning without concerns about distance and space. Reusable learning objects, a concept which is based on Sharable Content Reference Model (SCORM) standards, has been a fundamental framework to design and manage learning content.

Redundancy is something that must be avoided. The Korean Insurance Company realized that by also offering online and offline courses at a local district it "caused redundancy in topics and content. Furthermore, the quality of training varied depending on local districts. To remove redundancy and create efficiency in training services, the central training center produced e-learning courses that are sharable by all districts" (Kim, 2011).

To provide for easy accessibility any time, "a new e-learning environment was developed by integrating a mobile learning system with a typical e-learning environment. This brand new learning system enhances just-in-time learning opportunities for students such as sales personnel." (Kim, 2011) A good example is the utilization of a Personal Digital Assistance or PDA to access information anytime from any location.

But not all learning takes place in electronic environments. Abundant learning takes place in the workplace, not exactly in a formal classroom. Therefore, the place of work itself becomes a place of informal learning with different environments including Community of Practice (CoP), EPSS and KM, where mentorship is a common practice.

This is when "applied new technologies and training methods are interrelated. An example is integrating EPSS with KMS" (Kim, 2011). Conversion of learning objects into small modules can be useful by integrating different support systems.

By considering diverse types of learning efforts, making it accessible, easy to use, and by integrating technology-enhanced learning environments when performance improvements at work cannot be obtained by utilizing the same method or system, technology enhanced learning environments can be a great option.

For this to work, appropriate leadership should support training and development until the these technologies are implemented and proven to work. Second, the cost of setting up proper technology-enhanced systems are very high, therefore the company should consider this. Third, due to the amount of time required to have everything in place employees might get discourage. Perhaps, EPSS for a specific job should focus a small practice initially.

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Future

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Summary

When appreciated correctly and implemented conscientiously, adaptive learning therefore has immense potential to improve the experience and effectiveness of training delivery for both the student and the training deliverer.

As McGraw Hill assert:

'The field—which uses artificial intelligence to actively tailor content to each individual's needs—draws upon knowledge domains as diverse as machine learning, cognitive science, predictive analytics, and educational theory—to make this learner-centered vision of education a reality.'[48]

This report has therefore discussed the three ways training and content can be justified as adaptive: in appearance, sequencing and assessment. It has presented key advantages to underscore its potential to improve training content management and delivery. It has also offered guidance about the limits of what adaptive training can currently achieve, some of its known disadvantages and the limits of our current appreciation of its effectiveness for the professional community. This report has further highlighted a variety of methods of adaptive training delivery and detailed some current best practices in the field of adaptive training delivery.

These best practices may offer inspiration for those considering creating technology-supported and technology-enabled adaptive learning environments, both for the classic classroom-based student and for the liberated student.

[48] McGraw Hill (2017)'What is Adaptive Learning?' https://www.mheducation.com/ideas/what-is-adaptive-learning.html Accessed 25 March 2018

Analysis of Current Training Methods of AFB-500 Aviation Safety Inspectors and Recommendations for Improvement

The Federal Aviation Administration (FAA) employs many different types of Aviation Safety Inspectors (ASI) to promote and regulate safety in aviation. Under AFB-500 there are two categories of ASIs: General Aviation (GA) and Air Carrier (AC). Each of these two categories is further broken down into two sub categories: Operations (Ops) and Airworthiness (AW). The FAA has outlined a list of technical competencies for each of 4 ASI specialties. A complete list of courses for all 4 ASI specialties is located at the end of section 4.
The competencies for the GA Operations and Air Carrier Operations specialties are:

1. Air Agency Certification & Surveillance
2. Airman & Designee Certification and Surveillance
3. Air Carrier/Operator/Applicant Certification
4. Air Carrier/Operator Surveillance
5. Conducting Investigations
6. Providing Technical Assistance
7. Generating Reports and Documents (FAA, 2006a; FAA, 2006c)

The competencies for the GA Airworthiness and Air Carrier Airworthiness specialties are:

1. Air Agency Certification & Surveillance
2. Airman & Designee Certification and Surveillance
3. Air Carrier/Operator/Applicant Certification
4. Air Carrier/Operator Surveillance
5. Airworthiness Certificates
6. Conducting Investigations
7. Providing Technical Assistance
8. Generating Reports and Documents (FAA, 2006b; FAA, 2006d)

At face value, the Ops and AW specializations appear similar in terms of general categories, with only the AW list having one additional category of competency (Airworthiness Certificates). However, further detailed analysis of the competencies reveals that the training for Ops ASIs focuses on pilots, flight instructors, and flight schools, while the training for AW ASIs focuses on aviation maintenance technicians, repair centers, and aircraft airworthiness (FAA, 2006a; FAA, 2006b; FAA, 2006c; FAA, 2006d).

New Hire ASI Training

The training path an employee's follows depends on his or her job assignment and specialization. The new hire training process is divided into six phases, with each phase encompassing several different training courses. Phases 1, 3, and 5 are conducted via computer-based training modules on a learning management systems at the employee's workstation, while phases 2, 4, and 6 are conducted in a face-to-face classroom at the FAA Academy in Oklahoma City, Oklahoma. Additionally, training can take place in the field and other locations, such as PHASE V(a) of GA Ops training.

A summary of the duration of time of each of the 6 phases is shown in table 1. A summary of the number of courses per phase is shown in table 2.

Table 1. Summary of phase duration by specialization.

	Phase Duration					
Specialization	**1**	**2**	**3**	**4**	**5**	**6**
GA Ops	26.5 Hours	21 Days	45 Hours	19 Days	146 Hours	13 Days
AC Ops	26.5 Hours	19 Days	55 Hours	6 Days	44 Hours	22 Days
GA AW	26.5 Hours	21 Days	57 Hours	6 Days	46.5 Hours	14 Days
AC AW	26.5 Hours	19 Days	53 Hours	7 Days	66 Hours	19 Days

Table 2. Summary of the number of courses per phase by specialization.

	Number of Courses per Phase						
Specialization	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
GA Ops	10	6	11	5	22	3	57
AC Ops	10	6	11	2	17	3	49
GA AW	10	5	11	2	16	5	49
AC AW	10	5	10	2	24	4	55

Phase 1 consists of 10 computer-based training courses that are identical between all four ASI specializations. This phase consists of introductory and orientation type material. Phase 2 consists of 4 courses that are the same between all 4 specializations. After those 4 courses are completed the AW and Ops training differ slightly with 2 courses being taken by the Ops specialization and 1 different course taken by the AW specialization. For the remaining phases, 3 through 6, the training varies greatly with only a few courses being shared by each of the 4 specializations (shown in table 3).

Table 3. Number of similar courses by phase in the Ops specialization.

	Similar Courses					
Specialization	**1**	**2**	**3**	**4**	**5**	**6**
Ops	10	6	1	1	3	2
AWs	10	5	2	1	3	2

The total training time and number of courses of the 4 specialization varies, with the GA Ops specialization having the longest duration of training both in time and number of courses.

Flight Standards Training Program Testing Policy

Tests are administered for mandatory and non-mandatory Flight Standards training programs to measure whether or not employees have met the learning objectives. All employees are required to score 70% or higher on each learning component of the training. Attaining a score of 70% ensures that employees are knowledgeable on critical tasks, core knowledge, functional responsibilities, and other elements of performance that the training is designed to illicit. In addition to obtaining a 70% score or higher, all courses must be completed before

employees can proceed to the next phase of training. The structure of the training requires that employees be tested at multiple intervals throughout training so that weak areas can be identified and improved upon, as well as to ensure the employees meet the critical objectives of the courses learned. Additionally, the test results are reviewed during training and all missed questions are corrected to 100%. The testing policy requires all employees to complete the classroom-training that comprises of learning activities and test. "In rare cases where the classroom training is designed primarily to convey knowledge as opposed to teaching job-related procedures", employees may be allowed to "test out" and still receive credit for the training (FAA, 2005).

If an employee fails a test, the Training Division will provide the necessary remediation during the training program. The procedure of remediation offered depends on the method of training (i.e. classroom training or distance learning). If an employee that is enrolled in the classroom training method fails a test, his or her instructor will work with that employee to develop a remediation plan and spend extra time together reviewing the appropriate lessons and exercises. The employee will be allowed to take the test again when the instructor feels they are adequately prepared. In the event that the employee fails the test again, the employee's supervisor will be notified and provided the details about the learning objectives that were not met by the employee. The employee and his or her supervisor will develop a new remediation plan and a time table to manage the plan. The timetable must be 3 months or more and the activities in the plan could vary from on-the-job training to coaching/counseling methods depending on the employee's needs and supervisor's decision. The supervisor shall sign-off on the plan when it remediation is complete, and the employee will be authorized to re-enroll in the course and take all tests (FAA, 2005).

If the employee fails a test that is associated with distance learning, the distance learning application will guide the employee to the appropriate lesson that needs to be reviewed. After review, the employee is allowed to take the test again. A maximum of three repeat attempts are allowed using distance learning after which, the employee will be referred to a distance learning instructor for consultation and/or remediation. The distance-learning instructor will communicate with the employee's supervisor accordingly to determine if the employee will be allowed to re-take the tests (FAA, 2005).

Supervisors consider the employee's performance in training (i.e. pass or fail) as a factor to determine the overall performance appraisal of the employee. Therefore, employees in their initial probationary period will be carefully assessed by the supervisor to ensure they are capable of meeting the standards set by Flight Standards and whether or not employment will be continued. Employees that are not on their probationary period will be addressed through Human Resources (HR)

Measuring Training Effectiveness

AFB-500 uses the Kirkpatrick Model to measure training effectiveness. The four levels of the Kirkpatrick model measure:

1. The learner's reaction to the training
2. The learner's change in knowledge, attitudes, and/or skills
3. The behavior of the learner after training, specifically if the learner uses the training while on the job
4. The results and return on investment of the training for the company or organization

(Kirkpatrick & Kirkpatrick, 2006)

Currently, the FAA uses levels 1, 2, and 3 to measure the effectiveness of the training. For a level 1 evaluation, each new hire is given a survey after each course that assess their reaction to the course content, delivery method, and instructor. This survey also poses open ended questions to gain detailed comments from the learners. Reports are generated that provide this information to course developers and instructors. An example of this report is in figure 1.

Report Creator - Rating Statements

Division: **All** Branch: **All** Course: [redacted] Class: **All** Class FY: **18**
Type: **End-of-Course** Subtype: **RES** Evaluation Dates: **All** Question Level: **Academy** Status: **Active**

Academy Level Rating Statements							
Statement	**N/A**	**Negative Response**			**Positive Response**		
	Not Applicable	**Strongly Disagree**	**Disagree**	**Somewhat Disagree**	**Somewhat Agree**	**Agree**	**Strongly Agree**
1. The instructor(s) was knowledgeable about the subject.	0	0	0	1	5	27	35
2. The instructor(s) presented the material in an understandable way.	0	0	0	2	12	25	29
3. The instructor(s) was approachable and helpful.	0	0	0	1	5	19	42
4. The objectives were clearly presented for each lesson.	0	0	0	0	8	28	31
5. The course materials were up-to-date.	0	3	5	4	15	26	15
6. The course materials were understandable.	0	0	1	1	10	31	25
7. The learning environment was free from distractions.	0	0	0	1	4	30	33
8. The course provided training in an area important to my job.	0	1	0	0	5	20	41
9. The course was appropriately paced.	0	3	2	0	13	26	24
10. The course was organized to support understanding and learning.	0	0	0	0	9	31	28
11. The labs/workshops supported the lectures and increased my understanding and learning.	0	0	2	1	7	26	31
12. The written assessments reflected the course material presented.	0	0	0	0	5	30	33
13. The skill performance evaluation(s) assessed my proficiency level.	1	0	0	0	7	32	26
14. Overall this training was highly effective.	0	2	0	1	13	29	21
Total:	**1**	**9**	**10**	**12**	**118**	**380**	**414**

912 positive responses **31** negative responses **1** N/A responses total **944** responses

Favorable Rate = **96.7%**

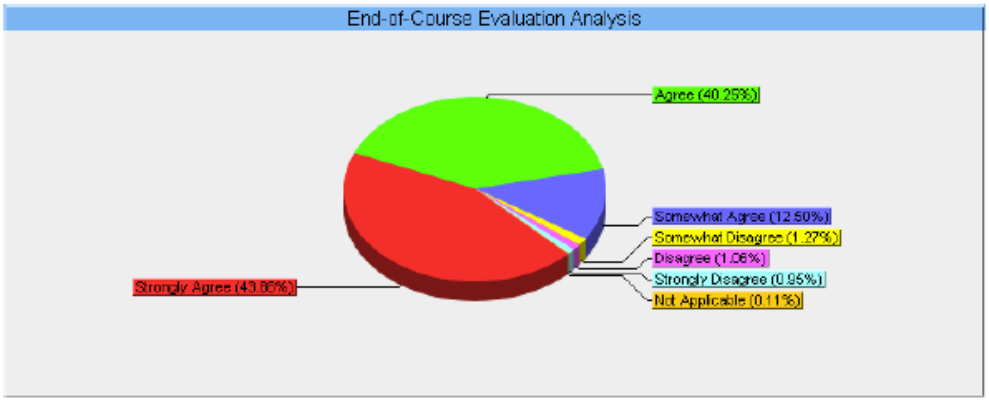

Figure 1. Example of Level 1 survey results.

A level 2 evaluation is completed by giving each new hire ASI a knowledge test on the topics presented in the course. A minimum score of 70% is required for each knowledge test. New hire's with a score of less than 70% are evaluated and retested as described in the FAA's Testing Policy. The course test results are de-identified and uploaded to the FAA's Electronic

Learning Management System (eLMS) for AFB-500 to analyze and measure the effectiveness of the training as well as the validity of tests. The analysis helps identify potential issues and serve as a framework to shape future tests and training methods.

A level 3 analysis is conducted approximately 6 weeks after training. This analysis is completed via a survey completed by the new hire and the new hire's supervisor. An example of the results of this survey are shown in figures 2 and 3. The total number of responses for Level 3 evaluation from supervisors is less than 50% of all requests to evaluate their new hires that took the course. Furthermore, only 1.76% of those surveyed provided any comments, and several of the comments from the supervisor survey state that the survey is completed too close to the end of training, and the supervisors cannot effectively rate the new hire's performance.

FAA Academy Evaluation System

Report Creator - Rating Statements

Division: **All** Branch: **All** Course: [redacted] Class: **All** Class FY: **17**
Type: **Post Course** Subtype: **Supervisor** Evaluation Dates: **All** Question Level: **Academy** Status: **Active**

Question	Yes	No
1. Was this training required for your employee's present job?	71	2
2. Has your employee had the opportunity to use the training they received in this course?	32	23

Academy Level Rating Statements

Statement	N/A	Negative Response			Positive Response		
	Not Applicable	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1. The course has improved the job-related knowledge and skills my employee needed.	4	0	0	1	9	41	12
2. My employee is applying the knowledge and skills learned in this course.	7	0	1	0	7	42	10
3. The training has improved my employee's job performance.	5	0	0	1	9	40	12
4. The training was worth the time and energy that my employee invested.	4	0	1	1	7	38	15
5. For my department, the training was worth the cost of employee leave time and tuition.	4	0	1	1	5	39	15
6. Overall, how satisfied were you with this course?	0	0	1	1	10	38	15
Total:	24	0	4	5	47	238	79

364 positive responses **9** negative responses **24** N/A responses total **397** responses

Favorable Rate = **97.6%**

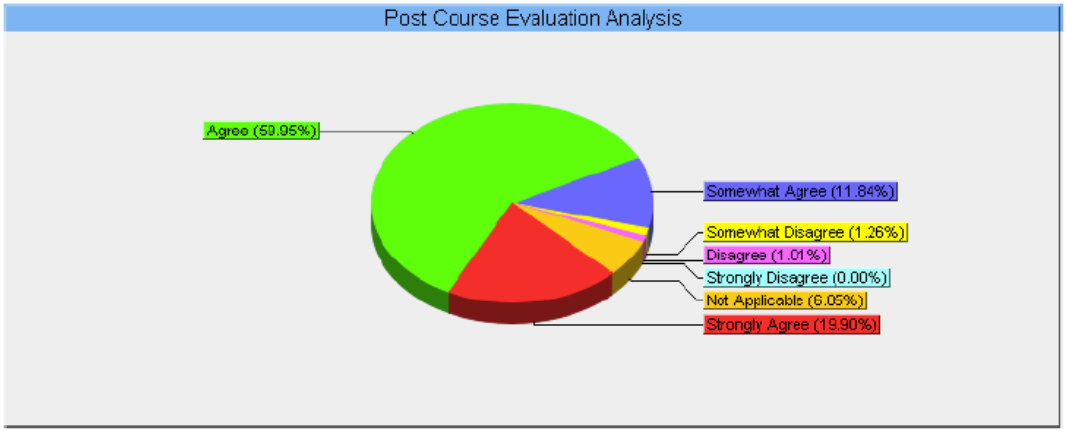

Figure 2. Example of Level 3 evaluation from new hire's supervisor.

Figure 3 shows an example of the survey results from the new hire ASI. The survey only asks the new hire's opinion of the course and does not test any knowledge from the course.

FAA Academy Evaluation System

Report Creator - Rating Statements

Division: **All** Branch: **All** Course: [redacted] Class: **All** Class FY: **17**
Type: **Post Course** Subtype: **Student** Evaluation Dates: **All** Question Level: **Academy** Status: **Active**

Question	Yes	No
1. Did you need this training for your present job?	166	1
2. Have you had the opportunity to use the training that you received?	71	57

Academy Level Rating Statements

Statement	N/A	Negative Response			Positive Response		
	Not Applicable	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1. The course has improved my knowledge and skills needed to perform my job.	1	0	2	2	30	83	45
2. I am applying the knowledge and skills I learned in this course.	12	4	6	7	33	64	38
3. The training has improved my job performance.	10	3	6	2	37	70	36
4. The training was worth the time and energy I invested.	0	1	5	4	29	74	49
5. Overall, how satisfied were you with this course?	0	1	3	2	36	81	39
Total:	23	9	22	17	165	372	207

744 positive responses **48** negative responses **23** N/A responses total **815** responses

Favorable Rate = **93.9%**

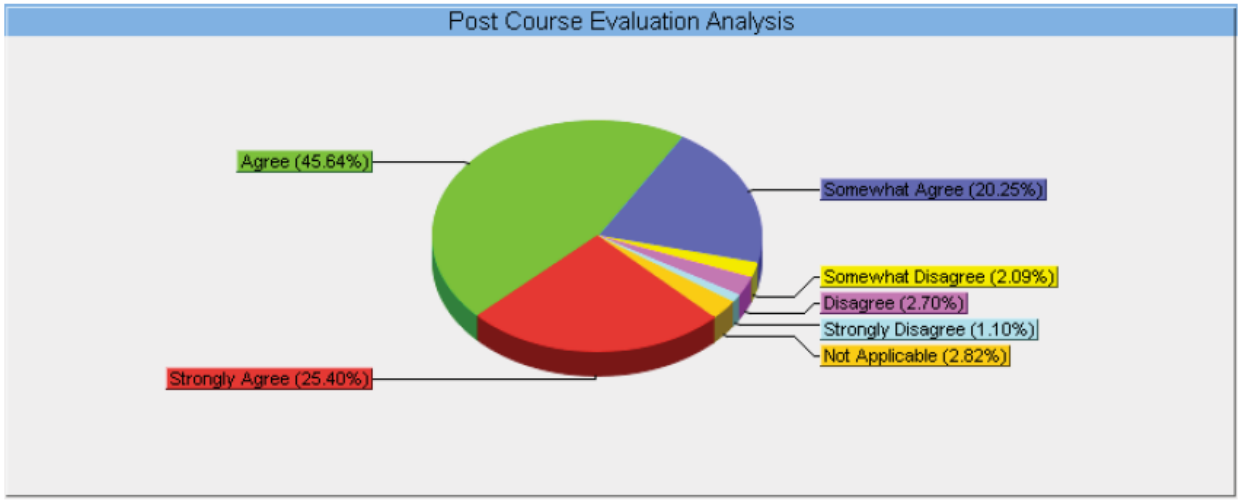

Figure 3. Example of Level 3 evaluation from new hire ASI.

Recommendations

Currently, there are no methods available to create a personalized training plan for new hire ASI's that builds on his or her previous aviation experience. All new hire's must take all courses of the new hire curriculum regardless of their knowledge and experience level. This situation does not offer any opportunity to have a testing out policy that adapts the training to the learner to take advantage of employee's knowledge and have hands-on-experience from their previous job(s) that is similar to their duties and responsibilities as an Aviation Safety Inspector

(ASI). For example, an employee that worked as a flight instructor in his or her previous job could be offered the option to test out of courses pertaining to basic aviation knowledge topics.

The current testing policy does provide an option to test out of courses if the classroom training is just to convey knowledge, which the testing policy states is "rarely the case" (FAA, 2005). The current testing policy could be amended to allow testing out of a complete course if the new hire passes a pre-course knowledge test designed to measure topical knowledge from that course. The newly developed pre-course knowledge test would ensure the new hire possess the knowledge contained in the course and could move on to the next step in training. If the new hire fails the pre-course knowledge test and completes the course, the results of the pre-knowledge test can be measured against a post-knowledge test for an accurate measure of knowledge gain after training. This would establish how much knowledge gain takes place because of the course as opposed to the current method which does not account for the prior knowledge of the new hire.

Another recommendation is to add another level 2 measure of training effectiveness in the form of a self-efficacy survey. Self-efficacy is defined as a person's individual belief and confidence in their ability to perform a specific task (Bandura, 1997). Evidence has shown that "efficacy beliefs contribute significantly to the level of motivation and performance" of an individual (Bandura & Locke, 2003, p. 87). An individual that has a high level of confidence in their own knowledge or skill at an activity will perform at a high level. Measuring the self-efficacy of an individual before training and again after training will allow a comparison to further assess the effectiveness of the training course. Additionally, in an adaptive training scenario, self-efficacy score could be an additional factor combined with knowledge score to judge if a new hire has the proper qualifications to test out of a particular course.

An analysis of the timing of Level 3 evaluations should be conducted to ensure that the surveys are being given at the appropriate time after the new hire completes his or her on the job training and is placed in their new ASI role. An initiative to increase response rate to a level higher than 50% should be conducted. Additionally, the new hire's level 3 survey should be adapted to include knowledge and self-efficacy questions to measure the learner's retention of new knowledge after the course.

Finally, course development should continue to produce courses in a modular format that allows the overlap of course topics to be shared by all 4 specializations for maximum course development efficiency. A modular format would also allow the option for new hires to test out of particular sections of a course, as opposed to the entire course, to provide the most flexibility in an adaptive training format. A review of the curriculum should be conducted to determine if any of the training courses provided in initial training could be given at a later time, closer to when the new hire would use them on the job. This could lessen the training time at the beginning of the new hire's position and allow for new hires to receive training as needed instead of all at once. This style of training would fit employees' backgrounds along with future job duties and responsibilities, making the training process more efficient.

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The following is new-hire string training.

PHASE I: (eLMS at employee's workstation) – 26.5 hours total instruction

Course #	Course Title	Training Length
27031	Orientation to the FAA, AVS, and Flight Standards	(3.5 hours)
27032	Introduction to AFS Business and Interpersonal Competencies for ASIs	(4 hours)
27034	Introduction to Authorizing Documents	(2.5 hours)
27035	Introduction to Manual Management	(3 hours)
20100028	Overview of Safety Management Systems	(2 hours)
20100148	Fundamentals of QMS for AFS	(2 hours)
20100187	Orientation to International Aviation	(4 hours)
20100190	Introduction to Safety Assurance System (SAS)	(2 hours)
20100214	Data Collection Tool Fundamentals for SAS	(2.5 hours)
30200646	Principles of Plain Language: Basic	(1 hour)

PHASE II: (classroom delivery at OKC) - 21 days total instruction

Course #	Course Title	Training Length
21000132	Initial Professionalism	(4 days - 32 hours)
21000059	Safety Management	(5 days - 40 hours)
21423	Flight Standards Automation Tools	(5 days - 40 hours)
21000099	Practical Application Workshop (PAW) for Orientation to International Aviation	(1 day - 4 hours)
21000125	ASI SAS Interactive Training	(4 days - 32 hours)
12062	Crew Resource Management (CRM) (Initial)	(2 days - 16 hours)

PHASE III: (eLMS at employee's workstation) - 45 hrs total instruction

Course #	Course Title	Training Length
2710	Introduction to Flight, Duty, and Rest Requirements	(2 hours)

0047		
2710 0048	Operator Training Programs	(2 hours)
2710 0052	Introduction to Minimum Equipment List/Configuration Deviation List	(2 hours)
2710 0053	Operational Control	(2 hours)
2710 0050	Personnel Qualifications	(2 hours)
2710 0070	Recordkeeping	(2 hours)
2710 0075	RVSM for GA Operations Inspectors	(2 hours)
2710 0103	Introduction to Airmen/Designees	(3 hours)
2710 0145	Overview of Agricultural Operations	(3 hours)
2710 0215	Introduction to the SAS External Portal for AFS	(5 hours)
The following course is a BB-ILT – new hires Must be scheduled to attend		
2710 0259	Safety and Compliance	(20 hours)

PHASE IV: (classroom delivery at OKC) - 19 days total instruction

Course #	Course Title	Training Length
21000081	En Route Inspection Procedures	(3 days - 24 hours)
18801	General Aviation Operations Indoctrination Ground	(2 days - 16 hours)
21000071	GA OPS Airmen/Designee Practical Applications Workshop	(3 days - 24 hours)
22100	14 CFR Part 135, Air Carrier Operations	(7 days - 56 hours)
21000053	GA OPS Practical Applications Workshop #1	(4 days - 32 hours)

PHASE V(a): GA Ops FLIGHT (AIRPLANE or HELICOPTER) – 90 hours total instruction

Course #	Course Title	Training Length
18803	Technically Advanced Aircraft (TAA) Self-Study Course	(8 hours)
21000138	Principals of Evaluation for GA ASIs - Airplane	(40 hours)
	OR	
27100116	GPS Refresher	(2 hours)
21000134	Principles of Evaluation for GA OPs ASIs - Helicopter	(40 hours)

PHASE V(b): (eLMS at employee's workstation) - 56 hours total instruction

Course #	Course Title	Training Length
270200	Ground Deicing/Anti-icing for Operations Inspectors	(4 hours)
27100049	Introduction to Part 141 Pilot School	(2 hours)
27100051	Introduction to Cabin Safety Programs	(2 hours)
27100067	Air Tour Operations	(2 hours)
27100068	CAT I, II, III Operations	(2 hours)
27100069	Base of Operations	(2 hours)
27100072	Extended Operations (ETOPS) for Part 135 Operators	(4 hours)
27100073	Station Facilities	(2 hours)

2710 0074	Introduction to Special Navigation Authorizations	(3 hours)
2710 0092	Voluntary Reporting Programs for GA Operations Inspectors	(2 hours)
2710 0093	Safety Programs for GA Operations Inspectors	(2 hours)
2710 0101	Public Aircraft Operations	(3 hours)
2710 0102	Selected Part 133 and 137 Authorizations for CAPs, and Class D, and IFR Operations	(3 hours)
2710 0109	Environmental Concerns in Aviation	(2 hours)
2710 0110	Aircraft Checklists for GA Operations Inspectors	(3 hours)
2710 0111	Aircraft Performance Programs for GA Operations Inspectors	(2 hours)
2710 0112	Aircraft Refueling for GA Operations Inspectors	(3 hours)
2710 0126	Contract Crewmember Training	(3 hours)
2710 0141	Introduction to Exemptions, Deviations, and Waivers or Authorizations	(2 hours)
2710 0257	Air Cargo Operations Web-based Training (WBT)	(8 hours)

PHASE VI: (classroom delivery at OKC) 13 days total instruction

Course #	Course Title	Training Length
21000056	Air Cargo Operations Practical Application Workshop (PAW)	(3 days - 24 hours)
00035	Basic Aircraft Accident Investigation	(8 days - 64 hours)
21000078	General Aviation Operations Practical Applications Workshop II (GA OPS PAW II)	(2 days - 16 hours)

The following is new-hire string training.

PHASE I: (eLMS at employee's workstation) – 26.5 hours total instruction

Course #	Course Title	Training Length
27031	Orientation to the FAA, AVS, and Flight Standards	(3.5 hours)
27032	Introduction to AFS Business and Interpersonal Competencies for ASIs	(4 hours)
27034	Introduction to Authorizing Documents	(2.5 hours)
27035	Introduction to Manual Management	(3 hours)
20100028	Overview of Safety Management Systems	(2 hours)
20100148	Fundamentals of QMS for AFS	(2 hours)
20100187	Orientation to International Aviation	(4 hours)
20100190	Introduction to Safety Assurance System (SAS)	(2 hours)
20100214	Data Collection Tool Fundamentals for SAS	(2.5 hours)
30200646	Principles of Plain Language: Basic	(1 hour)

PHASE II: (classroom delivery at OKC) – 21 days total instruction

Course #	Course Title	Training Length
21000132	Initial Professionalism	(4 days - 32 hours)
21000059	Safety Management	(5 days - 40 hours)
21423	Flight Standards Automation Tools	(5 days - 40 hours)
21000099	Practical Application Workshop (PAW) for Orientation to International Aviation	(1 day - 8 hours)
21000125	ASI SAS Interactive Training	(4 days - 32 hours)
12062	Crew Resource Management (CRM) (Initial)	(2 days - 6 hours)

PHASE III: (eLMS at employee's workstation) – 57 hours total instruction

Course #	Course Title	Training Length
20100015	Personnel Training Programs	(4 hours)

2710 0016	Airmen/Crewmember Checks & Qualifications	(3 hours)
2710 0018	Aircraft Performance Operating Limits	(3 hours)
2710 0020	Appropriate Operational Equipment	(4 hours)
2710 0021	Minimum Equipment List (MEL)/Configuration Deviation List (CDL) Procedures	(4 hours)
2710 0022	Dispatch/Flight Release	(4 hours)
2710 0023	Load Manifest and Weight and Balance Control	(4 hours)
2710 0024	Operational Control	(3 hours)
2710 0017	Pilot Operating Limitations/Recent Experience	(3 hours)
2710 0215	Introduction to the SAS External Portal for AFS	(5 hours)
The following course is a BB-ILT – new hires Must be scheduled to attend		
2710 0259	Safety and Compliance	(20 hours)

PHASE IV: (classroom delivery at OKC) - 6 days total instruction

Course #	Course Title	Training Length
21000081	En Route Inspection Procedures	(3 days - 24 hours)
21000049	Air Carrier Operations Practical Application Workshop (PAW)	(3 days - 24 hours)

PHASE V: (eLMS at employee's workstation) – 46.5 hours total instruction

Course #	Course Title	Training Length
27020	Ground Deicing/Anti-icing for Operations Inspectors	(4 hours)
27100084	Safety Programs	(2 hours)
27100120	Airmen Duties & Flight Deck Procedures (AC OPS)	(2 hours)
27100121	Routes, Airports, and Areas of Operation (AC OPS)	(3 hours)
27100122	Flight, Duty, & Rest Requirements (AC OPS)	(3 hours)
27100123	Cabin Safety Programs (AC OPS)	(3 hours)
27100125	Flight Simulator Training Device Qualification	(1.5 hours)
27100126	Contract Crewmember Training	(3 hours)
27100127	Aircrew Designated Examiner Programs	(2 hours)
27100128	Hazardous Material Training	(2 hours)
27100129	Advanced Qualifications Program (AQP)	(3 hours)
27100131	Reduced Vertical Separation Minimums (RVSM) for Air Carrier Operations ASIs	(2 hours)
27100132	Part 119 Management Personnel	(1 hour)
27100133	Voluntary Safety Programs (AC OPS)	(1 hour)
27100138	Air Carrier Ops ETOPS Advanced WBT	(4 hours)
27100141	Introduction to Exemptions, Deviations, and Waivers or Authorizations	(2 hours)
27100257	Air Cargo Operations Web-based Training (WBT)	(8 hours)

PHASE VI: (classroom delivery at OKC) – 14 days total instruction

Course	Course Title	Training

se #		Length
2100 0056	Air Cargo Operations Practical Application Workshop (PAW)	(3 days - 24 hours)
0003 5	Basic Aircraft Accident Investigation	(8 days - 64 hours)
2100 0103	Air Carrier Operations Practical Application Workshop (PAW) 2	(3 days - 24 hours)

The following is new-hire string training.

PHASE I: (eLMS at employee's workstation) – 26.5 hours total instruction

Course #	Course Title	Training Length
27031	Orientation to the FAA, AVS, and Flight Standards	(3.5 hours)
27032	Introduction to AFS Business and Interpersonal Competencies for ASIs	(4 hours)
27034	Introduction to Authorizing Documents	(2.5 hours)
27035	Introduction to Manual Management	(3 hours)
20100028	Overview of Safety Management Systems	(2 hours)
20100148	Fundamentals of QMS for AFS	(2 hours)
20100187	Orientation to International Aviation	(4 hours)
20100190	Introduction to Safety Assurance System (SAS)	(2 hours)
20100214	Data Collection Tool Fundamentals for SAS	(2.5 hours)
30200646	Principles of Plain Language: Basic	(1 hour)

PHASE II: (classroom delivery at OKC) Combined String for all specialties - 19 days total instruction

Course #	Course Title	Training Length
21000132	Initial Professionalism	(4 days - 32 hours)
21000059	Safety Management	(5 days - 40 hours)
21423	Flight Standards Automation Tools	(5 days - 40 hours)
21000099	Practical Application Workshop (PAW) for Orientation to International Aviation	(1 day - 8 hours)
21000125	ASI SAS Interactive Training	(4 days - 32 hours)

PHASE III: (eLMS at employee's workstation) – 55 hours total instruction

Course #	Course Title	Training Length
2710	Introduction to Minimum Equipment List/Configuration	(2 hours)

0052	Deviation List	
2710 0096	GA AW Weight and Balance Program	(2 hours)
2710 0097	GA Airworthiness Recordkeeping Programs	(4 hours)
2710 0098	GA AW Maintenance Audit Programs	(2 hours)
2710 0099	GA AW Aircraft Maintenance and Inspection Programs	(4 hours)
2710 0104	GA AW Operator Maintenance Training Programs	(4 hours)
2710 0105	GA AW Maintenance Facilities	(4 hours)
2710 0107	GA AW Parts and Parts Borrowing	(4 hours)
2710 0108	GA AW Maintenance Providers	(4 hours)
2710 0215	Introduction to the SAS External Portal for AFS	(5 hours)
The following course is a BB-ILT – new hires Must be scheduled to attend		
2710 0259	Safety and Compliance	(20 hours)

PHASE IV: (classroom delivery at OKC) - 6 days total instruction

Course #	Course Title	Training Length
21000064	GAAW Practical Applications Workshop #1	(3 days - 24 hours)
21000081	En Route Inspection Procedures	(3 days - 24 hours)

PHASE V: (eLMS at employee's workstation) – 44 hours total instruction

Course #	Course Title	Training Length
27019	Ground Deicing/Anti-icing for Airworthiness Inspectors	(4 hours)
27100141	Introduction to Exemptions, Deviations, and Waivers or Authorizations	(2 hours)
27100152	GA AW Introduction to Airmen and Designees	(4 hours)
27100153	GA AW Voluntary Programs	(3 hours)
27100154	GA AW RVSM	(2 hours)
27100159	Introduction to the AEG and AFS/AIR Interfaces	(2 hours)
27100162	Introduction to Part 147 Aviation Maintenance Technician Schools	(2 hours)
27100163	GA AW Operator Reporting	(2 hours)
27100164	GA AW Refueling	(2 hours)
27100173	Airworthiness Directives for General Aviation Airworthiness Inspectors	(2 hours)
27100174	Aircraft Airworthiness for General Aviation Airworthiness Inspectors	(2 hours)
27100175	Other Types of Aviation for General Aviation Airworthiness Inspectors	(3 hours)
27100180	GA AW ETOPS Part 135 for New Hire General Aviation Airworthiness Inspector	(2 hours)
27100181	GA AW Operator Safety Program for New Hire General Aviation Airworthiness Inspector	(2 hours)
27100182	GA AW Personnel Qualifications for New Hire General Aviation Airworthiness Inspector	(2 hours)
27100257	Air Cargo Operations Web-based Training (WBT)	(8 hours)

PHASE VI: (classroom delivery at OKC) – 22 days total instruction

Course #	Course Title	Training Length

21000090	GA AW Practical Application Workshop #2 for New Hire GA Airworthiness Inspectors	(3 days - 24 hours)
21000056	Air Cargo Operations Practical Application Workshop (PAW)	(3 days - 24 hours)
00035	Basic Aircraft Accident Investigation	(8 days - 64 hours)
21000091	GA AW Airman Practical Application Workshop for New Hire GA Airworthiness Inspectors	(3 days - 24 hours)
21058	Certification and Surveillance of Part 145 Repair Stations	(5 days - 40 hours)

The following is new-hire string training.

PHASE I: (eLMS at employee's workstation) – 26.5 hours total instruction

Course #	Course Title	Training Length
27031	Orientation to the FAA, AVS, and Flight Standards	(3.5 hours)
27032	Introduction to AFS Business and Interpersonal Competencies for ASIs	(4 hours)
27034	Introduction to Authorizing Documents	(2.5 hours)
27035	Introduction to Manual Management	(3 hours)
20100028	Overview of Safety Management Systems	(2 hours)
20100148	Fundamentals of QMS for AFS	(2 hours)
20100187	Orientation to International Aviation	(4 hours)
20100190	Introduction to Safety Assurance System (SAS)	(2 hours)
20100214	Data Collection Tool Fundamentals for SAS	(2.5 hours)
30200646	Principles of Plain Language: Basic	(1 hour)

PHASE II: (classroom delivery at OKC) – 19 days total instruction

Course #	Course Title	Training Length
21000132	Initial Professionalism	(4 days - 32 hours)
21000059	Safety Management	(5 days - 40 hours)
21423	Flight Standards Automation Tools	(5 days - 40 hours)
21000099	Practical Application Workshop (PAW) for Orientation to International Aviation	(1 day - 8 hours)
21000125	ASI SAS Interactive Training	(4 days - 32 hours)

PHASE III: (eLMS at employee's workstation) - 53 hrs total instruction

Course #	Course Title	Training Length
2710	Introduction to Air Carrier Maintenance Organization	(1 hour)

0003		
2710 0004	Introduction to Air Carrier Maintenance Programs	(2 hours)
2710 0007	General Maintenance Manual	(5 hours)
2710 0008	Minimum Equipment List (MEL)/Configuration Deviation List (CDL)	(4 hours)
2710 0009	Airworthiness Directives (AD) Management	(4 hours)
2710 0031	Maintenance and Inspection Programs	(6 hours)
2710 0032	Introduction to Evaluation of Vendors	(4 hours)
2710 0200	Introduction to Continuing Analysis & Surveillance Systems (CASS)	(2 hours)
2710 0215	Introduction to the SAS External Portal for AFS	(5 hours)
The following course is a BB-ILT – new hires Must be scheduled to attend		
2710 0259	Safety and Compliance	(20 hours)

PHASE IV: (classroom delivery at OKC) – 7 days total instruction

Course #	Course Title	raining Length
21000019	ACAW Maintenance Organization Practical Applications Workshop	4 days - 32 hours)
21000081	En Route Inspection Procedures	3 days – 24 hours)

PHASE V: (eLMS at employee's workstation) - 66 hours total instruction

Course #	Course Title	raining Length
27100033	Calibrated Tools and Test Equipment	2 hours)
27100034	Parts Pooling and Parts Borrowing	2 hours)
27100035	Short Term Escalation	2 hours)
27100041	Aircraft Fueling	2 hours)
27100042	Required Inspection Item (RII)	3 hours)
27100043	Maintenance Facility	3 hours)
27100044	Reduced Vertical Separation Minimums (RVSM) and Lower Landing Minimums (LLM)	4 hours)
27100056	Engine Condition Monitoring	2 hours)
27100057	Engineering/Major Repairs and Alterations	2 hours)
27100058	Parts, Material Control and Sup	3 hours)
27100059	Weight and Balance	3 hours)
270199	Ground Deicing/Anti-icing for Airworthiness Inspectors	4 hours)
27100078	Appropriate Operational Equipment	3 hours)
27100079	Aircraft Airworthiness	4 hours)
27100080	Records and Reporting Systems	4 hours)
27100081	Special Flight Permits	2 hours)
27100082	Maintenance Training Programs	2 hours)
27100083	Introduction to Extended Operations (ETOPS) Maintenance Programs (AC AWS)	2 hours)
27100084	Safety Programs	2 hours)
27100085	Voluntary Programs	1 hour)
27100086	Maintenance Personnel and Certification Requirements	2 hours)
2710	Introduction to Exemptions, Deviations, and Waivers or	

0141	Authorizations	2 hours)
2710 0159	Introduction to the AEG and AFS/AIR Interfaces	2 hours)
2710 0257	Air Cargo Operations Web-based Training (WBT)	8 hours)

PHASE VI: (classroom delivery at OKC) – 19 days total instruction

Course #	**Course Title**	**raining Length**
2100 0056	Air Cargo Operations Practical Application Workshop (PAW)	3 days - 24 hours)
0003 5	Basic Aircraft Accident Investigation	8 days - 64 hours)
2100 0060	Air Carrier Airworthiness Practical Applications Workshop #2	3 days - 24 hours)
2105 8	Certification and Surveillance of Part 145 Repair Stations	5 days - 40 hours)

Selecting the Right Learning Management System (LMS) or Learning Content Management System (LCMS)

C^2 Technologies, Inc.

INITIAL REPORT CONTENTS

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Purpose and Scope of this Report

The Federal Aviation Administration (FAA) has traditionally tackled training through a combination of web-based training programs and classroom instruction with Learning Management Systems (LMSs). This approach is suitable for compliance-focused training in which administrative items such as registration and completion tracking are critical. But traditional LMSs are severely limited within their capability to reach today's "connected learners." Many agency staff, especially those being onboarded currently or in the near future, have grown up online. As a result, their learning preferences and expectations demand much higher and meaningful interaction with the training materials, facilitators and each other.

With the rapid advancement of technology, it is not uncommon for a federal agency to periodically examine its Learning Management System (LMS)/Learning Content Management System (LCMS) system (in this instance eLMS, a Blackboard-based system), particularly if it's been used five years or more. It is time for the FAA to examine eLMS and its current competitors to make sure that the agency has the most effective tool in place to support a dynamic workforce – particularly a workforce that may need to implement more adaptive training methodologies.

The principal goal of this report is to evaluate 21st Century Learning Management Systems (LMS) and Learning Content Management Systems (LCMS) to assist FAA decision-makers involved in the process of choosing an LMS/LCMS to make an informed decision about the adoption of one system that would be appropriate for agency needs. To guide this evaluation, FAA provided a set of must-have features the potential modern-day LMS/LCMS should support: face-to-face learning, virtual classroom learning, and mobile learning and include the ability to handle adaptive learning, modular learning, evaluation of learning, and rapid updating capabilities. The report summarizes the results of that comparative review, including the main types of LMS/LCMS which exist, features and functions of systems to consider, and a simple process for selecting a modern LMS/LCMS.

Background: Learning Management System (LMS) and Learning Content Management System (LCMS)

An organization's LMS/LCMS serves an essential role in learner-centered teaching and learning practices. Because it manages the administration, delivery, monitoring and reporting of instructor-led, web-based and blended training programs, the most suitable LMS/LCMS provides a user-friendly environment while supporting the successful design of personalized learning experiences that support strong learning outcomes for all learners. An LMS/LCMS also provides automation that replaces tedious and expensive manual work and saves time. Furthermore, it reports on data that helps an organization measure training results and forecast demand.

Main LMS/LCMS Categories

There are five (5) main LMS/LCMS categories determined by organization type, cost, deployment, integration with other systems, and teaching strategy.

1. **Corporate vs. Academic:** In a corporate environment, the LMS tends to be oriented towards support for employee compliance and administration, or customer management. Alternatively, in academia, where the objective of the training process is usually to create well-rounded persons with deep knowledge of their subject area, the LMS/LCMS provides support for enrollment, grades, and basic reporting.

2. **Free (Open Source) vs. Commercial (Proprietary):** Organizations may elect to go after an open source system, for example, Moodle, if cost is a factor or there, is in-house experience, personnel, expertise, and server setup to manage a self-hosted LMS/LCMS. Though a free or open source LMS/LCMS has low up-front costs and grants the user flexibility to modify and control the system, there are many hidden costs that arise eventually, for example, recurring system maintenance and in-house or outsourced technical support. Based on the vendor, there will be varying levels of usage restrictions regarding Commercial LMS/LCMS software. These restrictions are typically enforced via a document called EULAs (End-user license agreements) to which users are supposed to acknowledge before using the software. Commercial software also has the added benefit of technical support (and maintenance if a cloud alternative is chosen).

3. **Cloud (Web-based/SAAS) vs. Installed (Self-Hosted):** Presently there are two (2) main types of commercial LMS/LCMS to consider - a cloud (SaaS - Software As A Service) LMS or an installed one, i.e., hosted onsite. In the former, all data is safely and securely stored in the cloud, and the vendor maintains and regularly upgrades the software at no extra price to the user. This is the best option to avoid maintenance, help desk support, and technical concerns, as the vendor is responsible for it. With the second option, the LMS/LCMS is typically hosted internally on the organization's servers, and the Information Technology team (IT) is in full control of the system specifications. Though self-hosted systems are highly customizable, IT has responsibility for the deployment, uptime, security, technical support and servicing.

4. **Integrated vs. Single-Purpose:** Nowadays, modern LMSs/LCMSs are expected to integrate with various other systems and applications that an organization already uses in its workflows, for example, Active Directory, Microsoft Office 365, social media networks, calendars, and email. They can also feed data into HR and talent management systems.

5. **Synchronous vs. Self-Paced:** The kind of learning that takes place is divided into one of two types: synchronous and asynchronous (self-paced). Synchronous learning describes a type of learning where students learn from instructors, colleagues, or peers in real time, but not face-to-face. Instructional content is delivered via modalities such as video conferences, interactive webinars, and chat-based online discussions. Asynchronous learning, alternatively, can occur even though the learner or facilitator is offline. Learning occurs in different locations and also at different times. In this case, instructional materials and communications are sent via web, email, and online message boards and learners usually complete the lessons on their own.

LMS/LCMS Pricing Models

While the benefits of using an LMS/LCMS are clear, the pricing structure can sometimes be confusing. LMS/LCMS software is usually priced based on two factors: the number of users and the functionality included. The more learners that are using the system and the greater the depth and breadth of functionality, the higher the price.

Pricing for Popular Systems

Here is a sampling of publicly available pricing for some of the systems included in this comparative evaluation. Detailed pricing information is available only upon request from vendors such as Blackboard, Canvas, and SABA.

Table 1. Sample Pricing

LMS	Pricing Model	1 - 99 Users	100 – 500 Users	500 – 999 Users	1,000+ Users
Matrix	Subscription /mo[49]	$169 - $399	$399 - $809	$999 - $1499	$1499+
Talent LMS	Subscription /mo[50]	$0 - $99	$99 - $349	$349+	

1. **Perpetual Licensing Fee (Self-Hosted):** In this case, the user pays a one-time flat fee that covers every part of the LMS/LCMS. The user downloads the program, hosts it locally, and can make use of it for however long they like. There is not an expiration date, and in most cases upgrades are included as part of the offer.
2. **Subscription:** The subscription pricing model involves an annual or monthly fee that users pay to use the LMS. No matter the amount of web-based courses or how many online learners access the web-based courses, the user will be billed the same flat fee. When the billing period ends, the user will pay to renew it to keep accessing the courses.
3. **Free Learning Management Systems:** There is a selection of LMS that is free to use, specifically those that derive from an open-sourced model.

Comparing Costs by Pricing Model

The following table compares the upfront, recurring, and other costs associated with each pricing model described.

Table 2. LMS/LCMS Requirements Matrix

LMS	Upfront Costs	Recurring Costs	Other Costs
Free & Open Source	High	Low	Medium
Subscription	Low	Medium	High
Perpetual	Low	High	Low

Considerations for Selecting a Modern LMS/LCMS

The earlier versions of LMSs traditionally focused on course administration, classroom management, and learner enrolment and were more administration focused, with cumbersome navigation. Modern LMSs/LCMSs, on the other hand, provide a simple and efficient learning environment where learners can easily access training materials on any device, anytime, anywhere.

[49] LMS Pricing | Learning Management System Costs » MATRIX LMS. (n.d.). Retrieved March 19, 2018, from https://www.matrixlms.com/info/plans

[50] Annual or Monthly LMS Pricing Plans - Cloud Solutions. (n.d.). Retrieved March 19, 2018, from https://www.talentlms.com/prices

Modern vs. Traditional LMS/LCMS

Here are some distinctive features of modern LMSs/LCMSs that make them stand out from traditional systems.

Table 3. Distinctive Features of Modern LMSs/LCMSs

FEATURE	TRADITIONAL LMS	MODERN LMS
Collaboration and Communication	Discussion boards, email	Discussion boards, email, Video conferencing, Chat, Journals, Social media, Instant messaging, wikis, blogs
Content Authoring	Simple Course Builder, Rapid Authoring Tools Sophisticated and structured authoring for courses, presentations, printed guides, job aids, web pages, and Flash	Granular learning content separated from the presentation for rapid assembly and reuse across any output format or audience
Course Administration	Course Enrollment, Completion Rules, Classroom Management	Course Enrollment, Learning Paths, Classroom Management, Competency Management, Certification Management
End User Tools	Browse Catalog, Simple Search, Email notification	Browse Catalog, Faceted Search, Individual Development Plan, Dynamic Recommendations, Learning Paths, Learner/Manager Dashboards, Email/Text Notifications, Ratings and Reviews, Badges/Leaderboards,
Learner Engagement	Classroom, Desktop	Classroom plus on-demand learning via web or mobile: anytime, anywhere, and on any device.
Reporting and Analytics	Completion Tracking, Test Scores	Centralized Learning Record Store (LRS) for reporting and analytics, Completion Tracking, Test Scores, Question Analytics, Informal Learning Activities, Social Learning Activities, Content Effectiveness

Requirements

There are hundreds of LMS/LCMS solutions on the market, so a method for narrowing down the selections is critical. Gathering requirements from stakeholders as well as reviewing product descriptions help form the basis of any selection criteria and facilitates the screening out of non-qualifying solutions. The clearer and more complete the LMS requirements, the easier it is to evaluate products. Here are the high-level requirements that will be used to conduct a review of each system.

Technical Environment

- Security
- Privacy Networking
- Hardware

Formal Requirements

- Face-to-Face (Classroom) Courses
- Virtual Classroom Learning

- Mobile Learning
- Modular Learning
- Adaptive Learning
- Rapid Updating
- Evaluation of Learning (e.g., reporting & analytics)
- Requirements Characteristic of Modern LMS/LCMS
    - Content Authoring
    - Dashboards
    - Offline Access
    - Web-based/Mobile Administration
    - Audit-Ready Certification
    - Competency Management
    - Collaboration and Communication
    - Gamification (e.g., awards, points, badging)
    - Third-party Integrations (e.g., APIs, HR, Skillsoft)

Government Regulations

- Section 508 Revised
- Privacy Act

Interoperability Standards & Technologies

- AICC
- Tin Can (xAPI)
- Single Sign-On (SSO) based on the SAML2 and LDAP standards
- SCORM

Evaluating Available LMS/LCMS

We used the following high-level process, which was partly adapted from the Advanced Distributed Learning (ADL) paper titled, *Choosing a learning management system* (Berking & Gallagher, 2011). For the purpose of this comparison, these steps were taken:

1. Determine High-Level Requirements
2. Identify LMSs/LCMSs for Consideration
3. Assess LMS/LCMS Identified for Consideration
4. Screen-out LMS/LCMS not Meeting Minimum Requirements
5. Prepare a Detailed Features List
6. Compare Top Three (3) LMS/LCMS

Determine High-Level Requirements

To guide this comparison, FAA provided ahead of time, a list of must-have features the potential modern LMS/LCMS should support. They are:

- Face-to-Face (Classroom) Courses
- Virtual Classroom Learning
- Mobile Learning
- Modular Learning
- Adaptive Learning
- Rapid Updating
- Evaluation of Learning

Identify LMSs/LCMSs for Consideration

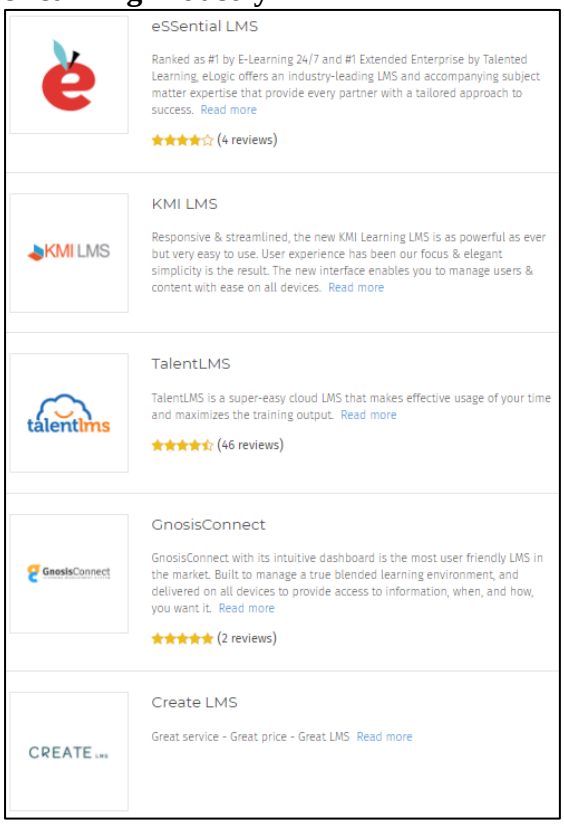
Next, we conducted peer and market research to learn about the LMS usage and industry trends, and to discover modern LMSs/LCMSs that might meet FAA's requirements. Of the several comparison sites available, we conducted market research using these sites:

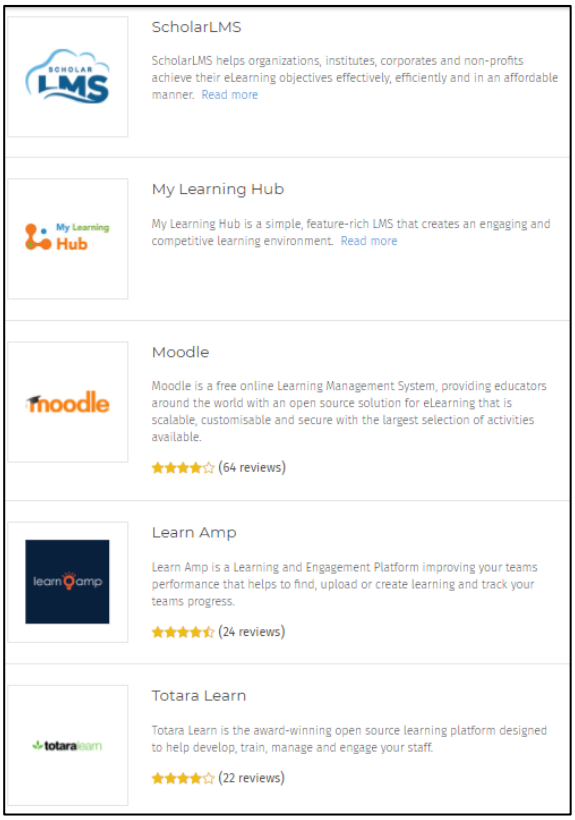
- Capterra
- eLearning Industry
- Finances Online
- PC Magazine Online
- Software Advice

At the time of our research, these were the current top systems on each website.

Capterra[51]

eLearning Industry[52]



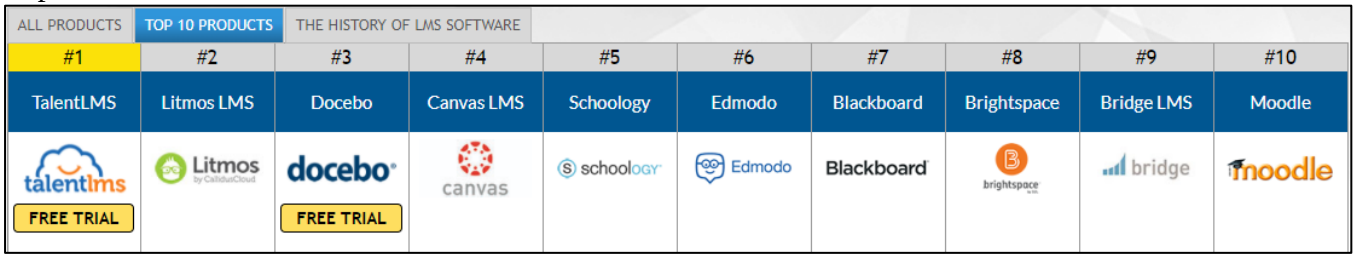


[51] Capterra. (n.d.). Best LMS Software | 2018 Reviews of the Most Popular Systems. Retrieved March 19, 2018, from https://www.capterra.com/learning-management-system-software/

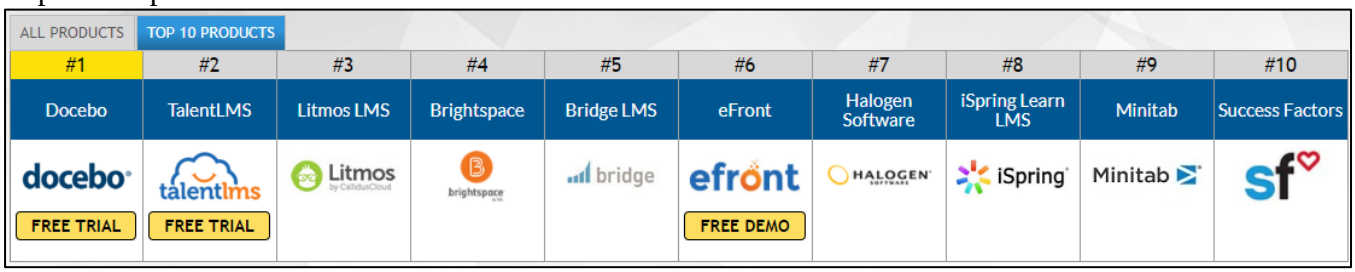
[52] Learning Management Systems for Public Administration Companies. (n.d.). Retrieved March 19, 2018, from https://elearningindustry.com/directory/software-categories/learning-management-systems/market/public

Finances Online[53]

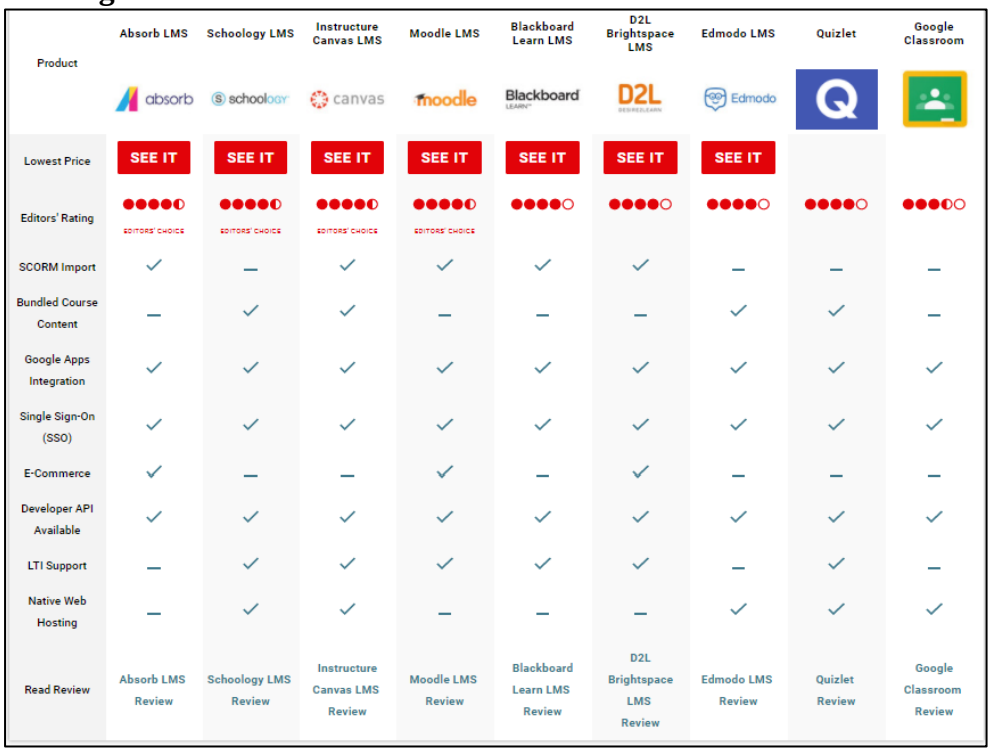
Top 10 LMS



Top 10 Corporate LMS



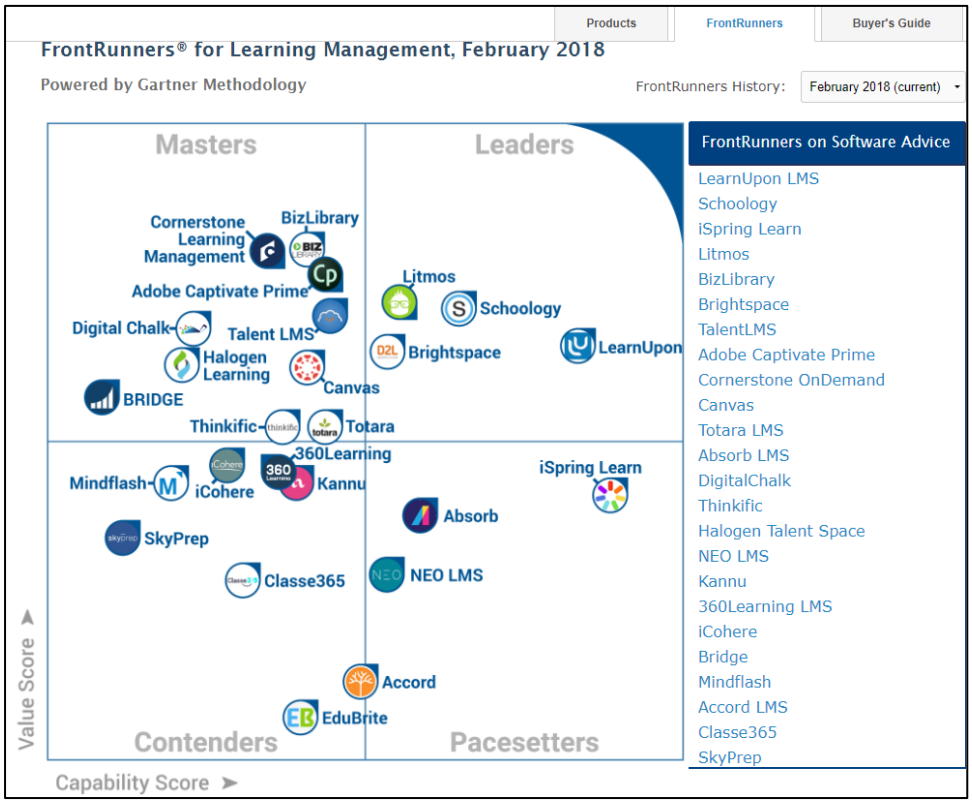
PC Magazine Online[54]



[53] Best Learning Management Systems Software Reviews & Comparisons | 2018 List of Expert's Choices. (n.d.). Retrieved February 22, 2018, from https://learning-management-system.financesonline.com

[54] Fenton, B. W., January 12, 2018 5:04PM EST, & January 12, 2018. (n.d.). The Best (LMS) Learning Management Systems for 2018. Retrieved March 21, 2018, from https://www.pcmag.com/article2/0,2817,2488347,00.asp

Software Advice[55]



In the end, for further analysis, we selected eight (8) systems that were either already adopted by other federal agencies or in the top lists, plus Blackboard, which is the backbone of the existing FAA LMS, eLMS.

- Absorb
- Blackboard Learn
- Canvas
- Desire 2 Learn (D2L)
- Matrix
- Moodle/Moodlerooms
- SABA Learning
- Talent LMS

[55] Westfall, B. (n.d.). Best Learning Management Systems - 2018 Reviews & Pricing. Retrieved March 19, 2018, from https://www.softwareadvice.com/lms/

Assess LMS/LCMS Identified for Consideration

After conducting peer and market research, we used a requirements matrix, as shown in Table 1., to assess the eight (8) systems that were selected for further review.

Table 4. LMS/LCMS Requirements Matrix[56]

LMS/LCMS REQUIREMENTS MATRIX								
	Absorb	**Blackboard Learn**	**Canvas**	**D2L**	**Matrix**	**Moodle**	**SABA Learning**	**Talent LMS**
HIGH-LEVEL REQUIREMENTS								
Face-to-Face Learning	✓	✓	✓	✓	✓	Via Face-to-face addon	✓	✓
Virtual Classroom Learning	✓	✓	✓	✓	✓	x	✓	✓
Mobile Learning	Web-based (HTML5)	Web-based (HTML5) Native iOS and Android Apps	Web-based (HTML5) Native iOS and Android Apps	Web-based (HTML5) Native iOS and Android Apps	Native iOS, Android, and Windows Apps	Native iOS and Android Apps	Native iOS (SABA Cloud) and Android Apps (SABA Cloud & SABA Enterprise)	Web-based (HTML5) Native iOS and Android Apps
Modular Learning	✓	✓	✓	✓	✓	✓	✓	✓
Adaptive Learning	Personalized Learning Paths	Via IADLearning addon	MasteryPaths, content recommendations, personalized learning paths, pre- and post-tests	Learning Paths adapts to learners' strengths and weaknesses	Personalized competency-based learning; content and assignments available based on the student's assessment scores and mastery of the content	Via IADLearning addon	Rules-based personalized learning paths, pre- and post-tests	Rules-based personalized learning paths

[56] Berking, P., & Gallagher, S., (2016, June 1). Choosing a Learning Management System (Ver. 8.0). Advanced Distributed Learning (ADL) Co-Laboratories, 40–62.

Table 1

APPENDIX

LMS/LCMS REQUIREMENTS MATRIX								
	Absorb	**Blackboard Learn**	**Canvas**	**D2L**	**Matrix**	**Moodle**	**SABA Learning**	**Talent LMS**
HIGH-LEVEL REQUIREMENTS								
Rapid Updating	Built-in content authoring	Built-in content authoring	Built-in content authoring	Built-in content authoring	Built-in content authoring, Learning Objects	Built-in content authoring	Built-in content authoring	Built-in content authoring
Evaluation of Learning	Leaderboards, auto reports, e.g., learner activity, assessments, certificates, competencies	Reports, certificates, competencies	Reports, gradebook competencies, Speedgrader, rubrics	reports (e.g., automatic, email delivery), certificates	Reports (e.g., ad-hoc & automatic reports),learner activity, certificates, competencies	Gradebook, skills tracking, assessments, certificates	Reports, certificates, competencies	Reports
Collaboration and Communications	✓	✓	✓	✓		BigBlueButton addon	✓	✓
Gamification	Mercury Module upgrade	✓	Credly addon[57]	✓	✓	LevelUp, Quizventure addon	✓	✓
User Dashboards	✓	✓	✓	✓	✓	✓	✓	✓
Offline Access/Mode	✓	✓	✓	✓	Later 2018	Via app	✓	✓
Third-party Integrations	✓	✓	✓	✓	✓	✓	✓	✓
Government Regulations	Section 508	Section 508	Section 508	Section 508	Section 508	Section 508	Section 508	Section 508
Content Interoperability and Course Management	AICC, SCORM, Tin Can (xAPI), single sign on	AICC, SCORM, Tin Can (xAPI), IMS LTI	AICC, SCORM, Tin Can (xAPI), IMS LTI	AICC, SCORM, Tin Can (xAPI), IMS Common Cartridge, IMS LTI	SCORM Tin Can (xAPI) IMS Common Cartridge IMS LTI, SAML single sign-on	AICC SCORM Tin Can (xAPI)	AICC SCORM Tin Can (xAPI)	SCORM Tin Can (xAPI)

[57] Credly. (n.d.). Digital Credentials | Credly. Retrieved March 19, 2018, from https://credly.com

Table 1

Screen-out LMS/LCMS not Meeting Minimum Requirements

The next task involved eliminating those systems that failed to meet the minimum requirements. As a result of our investigations, Blackboard Learn, Canvas and D2L were identified as the finalists for the final evaluation.

Prepare a Detailed Features List[58] [59]

After narrowing down the potential systems to three (3), we conducted a more in-depth review of each system to identify additional features to compare. Features are grouped by:

- Technical Environment
- Formal Requirements
- Government Regulations
- Interoperability Standards & Technologies

1. Technical Environment (e.g., security, privacy, networking, & hardware)
    - IP Blocker
    - Anti-spam
    - Anti-virus
    - Strong Passwords
    - Restrict registration to specific domains
    - Security Certification & Accreditation
    - Transport Layer Security (TLS)
    - Public-Key Infrastructure (PKI)
    - Federal Information Processing Standard (FIPS – 140-1)

2. Formal Requirements
    - Face-to-Face (Classroom) Courses
        - Build multiple classes for a single course
        - Enable learners to self-register from a list of available classes
        - Classroom waitlist feature with administrator tools
        - Instructors can retrieve training item
        - Capture attendees via an electronic class roster
        - Integrate class registration with Outlook calendars
    - Virtual Classroom Learning
    - Mobile Learning
    - Modular Learning
    - Adaptive Learning
        - Provides a course opt-in feature that can be used for pre- and post-tests
        - Generates dynamic personalized learning pathways for each learner
        - Recommends content using machine learning and big data
        - Assignments can be assigned to specific learners
        - Content and assignments can be denoted as required or optional

[58] Berking, P., & Gallagher, S., (2016, November 4). Choosing a Learning Management System (Ver. 8.0). Advanced Distributed Learning (ADL) Co-Laboratories, 40–62.

[59] Fenton, B. W., January 12, 2018 5:04PM EST, & January 12, 2018. (n.d.). The Best (LMS) Learning Management Systems for 2018. Retrieved March 21, 2018, from https://www.pcmag.com/article2/0,2817,2488347,00.asp

- Learners can customize their training by selecting content and assignments within a learning path
- Hide/show content based on assessment scores and master

    - Supplemental materials can be automatically released to learners based on performance on quizzes or assignments
    - Seamlessly integrated with the automation system
- Rapid Updating
    - Built-in content authoring
    - Reusable Learning Objects (e.g., assessments, PPTs, PDFs, surveys, tasks, videos)
- Evaluation of Learning (e.g., reporting & analytics)
    - Reporting functionality tool to create standard reports on users, completions, training activities, courses, and qualifications
    - Export data in Excel format for further processing
    - Automated scheduling and e-mail reports to users
    - Ability to schedule report delivery to senior level management
    - Tracking functionality for all users, training, and curricula
    - Qualification and resource management
- Requirements Characteristic of Modern LMS/LCMS
    - Dashboards
    - Offline Access (disconnected Mobile app)
    - Web-based/Mobile Administration
    - Certificates
        - Allows administrator design/upload and learner delivery of course completion certificates
        - Allows easy printing of certificates, surveys, and evaluations
    - Competency Management
        - Supports competency management
        - Evaluates competencies after learning
        - Automatically links training interventions and competency objects based on user approval
        - Imports/exports competency-related data in common database formats such as XML or MS Access
        - Prioritizes competencies and courses based on changes in career, regulations, funding, or organizational vision/mission
        - Can import competency inventories and rubrics as well as learner data from external systems
        - Uses a variety of competency frameworks (e.g., 360-degree Feedback)
        - Can provide IDP progress, training completion, and other related input to competency management, performance appraisal and other HR components of other systems
        - Can provide automated analysis/assessment survey of staff`s current and anticipated skills and competencies. Gaps are identified with appropriate courses indicated to address closure of gap(s).
    - Collaboration and Communication
        - Allows learners to take notes as they interact with learning materials. These notes should be persistent between sessions and automatically associated with locations in the content. If the learner

wishes, their notes can be posted, either internally in the LMS, or publicly outside of the LMS, through APIs to applications like Twitter and Facebook.

- Includes collaboration functions to enable users to communicate with each other, instructors, course administrators, system administrators, etc. These functions typically include:
    - Chat/Instant messenger (IM)
    - Threaded discussion and Blogs
        - Attach documents associated with a posting (students)
        - Embed links (students)
        - Allow creation of groups (instructors)
        - Make postings anonymous and/or private that cannot be viewed by anyone higher in the organizational hierarchy (i.e., vertical social network)
        - Search (students and instructors)
        - Set release conditions (instructors)
        - Moderate (instructors)
        - Use rubrics to grade postings (instructors)
    - File sharing
        - Allows learners to include comment tags
        - Allow check-in and check-out version controls
        - Incorporates a user rating system (for relevancy, quality, etc.)
        - Accepts a variety of file types, such as;
            - PDF
            - Video
            - Web pages
            - MS Office
            - Zip archives
    - Journals
    - Social networking
    - Instant messaging
    - Communities of practice (CoPs) or dedicated team spaces
    - Community calendar
    - Surveys
    - Peer rating of content
    - Video Conferencing
    - Learner to learner whiteboard
    - Desktop sharing
- Provides infrastructure for coaching, mentoring, and other informal learning paradigms

- Gamification (e.g., awards, points, badging)
    - Badges
    - Badge customization

- Points
- Rewards
- Levels
- Leaderboards
- Customize Gamification mechanic

- Third-party Integrations (e.g., APIs, HR,)
    - CAS
    - SAML
    - Adobe Connect
    - Google Docs
    - Google Calendar
    - SharePoint
    - Outlook, iCal, Google
    - Skillsoft
    - Twitter
    - Skype
    - SMS
    - YouTube
    - Vimeo
    - LinkedIn
    - Big Blue Button
    - ExamView
    - LaTex
    - Flickr
    - WebCT (Blackboard Vista)
    - Blackboard
    - Angel
    - Moodle 1.9/2.x
    - D2L

3. Government Regulations
    - Section 508
    - Privacy Act

4. Interoperability Standards & Technologies
    - AICC
    - Tin Can (xAPI)
    - Single Sign-On (SSO) based on the SAML2 and LDAP standards
    - SCORM:
        - Is certified or has been tested for conformance.
        - Support all SCORM data model elements (SCORM 2004)
        - Retains visibility for the TOC when a SCO has been launched
        - Shows both ― "attempted" status as well as ―"completion."
        - Is not overly proprietary in its implementation and handling of SCORM calls other than ―attempted‖ and ―completion."
        - Supports multi-byte (Unicode) fonts (esp. Asian language characters) and right-to-left languages. This requires that the LMS interface text is stored as data, separate from source code.
        - Offers flavors of the interface in foreign languages for global reach

- Supports the Training and Learning Architecture (TLA). See 5.12.7 Training and Learning Architecture (TLA)

Compare Top Three (3) LMS/LCMS

These features were then used to create an LMS feature rating tool like the one shown below[60]. See *Annex A: LMS/LCMS Features Rating Tool* for an example of the complete rating tool, and the spreasheet, *Annex A: LMS/LCMS Features Rating Tool.xls* to use in your comparison.

Table 1. Example of an LMS/LCMS Features Rating Tool

REQUIREMENTS	Weight	[SPECIFY LMS 1]		[SPECIFY LMS 2]		[SPECIFY LMS 3]	
		Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
1. TECHNICAL							
1.1. IP Blocker							
1.2. Anti-spam							
1.3. Anti-spam							
1.4. Anti-virus							
1.5. Strong Passwords							
1.6. Restrict registration to specific domains							
1.7. Security Certification & Accreditation							
1.8. Transport Layer Security (TLS)							
1.9. Public-Key Infrastructure (PKI)							
1.10. Federal Information Processing Standard (FIPS – 140-1)							
Total			0		0		0

[60] Berking, P., & Gallagher, S., (2016, November 4). Choosing a Learning Management System (Ver. 8.0). Advanced Distributed Learning (ADL) Co-Laboratories, 40–62.

Next Steps

Upon FAA review of this report, a meeting will be conducted with FAA stakeholders to find out what they want from adaptive learning, and to identify appropriate course content for the development of a prototype to be tested on the chosen LMS/LCMS. FAA will then host a pilot to discover and document facilitator's and learners' perceptions of the chosen LMS/LCMS and to determine whether it would be a good fit to meet the FAA's needs. All pilot participants will be asked to complete a summative assessment to share their experience with the pilot**.**

LMS/LCMS Features Rating Tool

Instructions

To use the matrix:

5. Replace the top row ([SPECIFY LMS 1], [SPECIFY LMS 2], etc.) with the names of the three (3) systems you have identified for final consideration.
6. For each Weight cell in the column to the right of the Feature name, enter a number between 1-3 to weight the relative importance of that feature to FAA (the higher the number, the more important).

   Weighting Factor

   3 = Must Have; 2 = Should Have; 1 = Nice to Have
7. For each Rating cell, enter a number between 1-5 to rate the degree to which each system has that feature (the higher the number, the more "out of the box" it is).

   Scoring

   5 = Automatic (built-in, out of the box feature)
   4 = Semi-Automatic (mostly built-in, but requires some programming or customization to activate)
   3 = Semi-custom (partially available. The system can be adapted to implement this feature through moderate customization)
   2 = Custom (not available but can be added, possibly at a high cost, with programming)
   1 = Not Available (would be impossible or cost-prohibitive to customize the system to add the feature due to incompatibilities with system architecture, etc.)
8. The rollup score row at the bottom will provide the total weighted score for each system (right-click on it and select Update Field after you make any changes to the weighting values or ratings). Formulas in the cells multiply the weighting factor for each feature by the degree of implementation feature described above; those scores are then added to make the totals at the bottom of each row.

REQUIREMENTS	Weight	[SPECIFY LMS 1]		[SPECIFY LMS 2]		[SPECIFY LMS 3]	
		Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
1. TECHNICAL							
1.1. IP Blocker							
1.2. Anti-spam							
1.3. Anti-spam							
1.4. Anti-virus							
1.5. Strong Passwords							
1.6. Restrict registration to specific domains							
1.7. Security Certification & Accreditation							
1.8. Transport Layer Security (TLS)							
1.9. Public-Key Infrastructure (PKI)							
1.10. Federal Information Processing Standard (FIPS – 140-1)							
2. FACE-TO-FACE (CLASSROOM) COURSES							
2.1. Build multiple classes for a single course							
2.2. Enable learners to self-register from a list of available classes							

REQUIREMENTS	Weight	[SPECIFY LMS 1]		[SPECIFY LMS 2]		[SPECIFY LMS 3]	
		Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
2.3. Classroom waitlist feature with administrator tools							
2.4. Instructors can retrieve training item							
2.5. Capture attendees via an electronic class roster							
2.6. Integrate class registration with Outlook calendars							
3. VIRTUAL CLASSROOM LEARNING							
4. MOBILE LEARNING							
5. MODULAR LEARNING							
6. ADAPTIVE LEARNING							
6.1. Provides a course opt-in feature that can be used for pre- and post-tests							
6.2. Generates dynamic personalized learning pathways for each learner							
6.3. Recommends content using machine learning and big data							
6.4. Assignments can be assigned to specific learners							
6.5. Content and assignments can be denoted as required or optional							
6.6. Learners can customize their training by selecting content and assignments within a learning path							
6.7. Hide/show content based on assessment scores and master							
6.8. Supplemental materials can be automatically released to learners based on performance on quizzes or assignments							
6.9. Seamlessly integrated with the automation system							
7. RAPID UPDATING							
7.1. Built-in content authoring							
7.2. Reusable Learning Objects (e.g., assessments, PPTs, PDFs, surveys, tasks, videos)							
8. EVALUATION OF LEARNING							
8.1. Reporting functionality tool to create standard reports on users, completions, training activities, courses, and qualifications							
8.2. Export data in Excel format for further processing							

REQUIREMENTS	Weight	[SPECIFY LMS 1]		[SPECIFY LMS 2]		[SPECIFY LMS 3]	
		Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
8.3. Automated scheduling and e-mail reports to users							
8.4. Ability to schedule report delivery to senior level management							
8.5. Tracking functionality for all users, training, and curricula							
8.6. Qualification and resource management							
9. DASHBOARDS							
10. OFFLINE ACCESS (DISCONNECTED MOBILE APP)							
11. WEB-BASED/MOBILE ADMINISTRATION							
12. CERTIFICATES							
12.1. Allows administrator design/upload and learner delivery of course completion certificates							
12.2. Allows easy printing of certificates, surveys, and evaluations							
13. COMPETENCY MANAGEMENT							
13.1. Supports competency management							
13.2. Evaluates competencies after learning							
13.3. Automatically links training interventions and competency objects based on user approval							
13.4. Imports/exports competency-related data in common database formats such as XML or MS Access							
13.5. Prioritizes competencies and courses based on changes in career, regulations, funding, or organizational vision/mission							
13.6. Can import competency inventories and rubrics as well as learner data from external systems							
13.7. Uses a variety of competency frameworks (e.g., 360-degree Feedback)							
13.8. Can provide IDP progress, training completion, and other related input to competency management,							

REQUIREMENTS	Weight	[SPECIFY LMS 1]		[SPECIFY LMS 2]		[SPECIFY LMS 3]	
		Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
performance appraisal and other HR components of other systems							
13.9. Can provide automated analysis/assessment survey of staff's current and anticipated skills and competencies. Gaps are identified with appropriate courses indicated to address closure of gap(s)							
14. COLLABORATION AND COMMUNICATION							
14.1. Allows learners to take notes as they interact with learning materials. These notes should be persistent between sessions and automatically associated with locations in the content. If the learner wishes, their notes can be posted, either internally in the LMS, or publicly outside of the LMS, through APIs to applications like Twitter and Facebook.							
14.2. **Includes collaboration functions to enable users to communicate with each other, instructors, course administrators, system administrators, etc. These functions typically include:**							
14.2.1. Chat/Instant messenger (IM)							
14.2.2. **Threaded discussion and Blogs**							
14.2.2.1. Attach documents associated with a posting (students)							
14.2.2.2. Embed links (students)							
14.2.2.3. Allow creation of groups (instructors)							
14.2.2.4. Make postings anonymous and/or private that cannot be viewed by anyone higher in the organizational hierarchy (i.e., vertical social network)							
14.2.2.5. Search (students and instructors)							

REQUIREMENTS	Weight	[SPECIFY LMS 1]		[SPECIFY LMS 2]		[SPECIFY LMS 3]	
		Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
14.2.2.6. Set release conditions (instructors)							
14.2.2.7. Moderate (instructors)							
14.2.2.8. Use rubrics to grade postings (instructors)							
14.2.3. **File sharing**							
14.2.3.1. Allows learners to include comment tags							
14.2.3.2. Allow check-in and check-out version controls							
14.2.3.3. Incorporates a user rating system (for relevancy, quality, etc.)							
14.2.3.4. **Accepts a variety of file types, such as;**							
14.2.3.4.1. PDF							
14.2.3.4.2. Video							
14.2.3.4.3. Web pages							
14.2.3.4.4. MS Office							
14.2.3.4.5. Zip archives							
14.2.4. Journals							
14.2.5. Social networking							
14.2.6. Instant messaging							
14.2.7. Communities of practice (CoPs) or dedicated team spaces							
14.2.8. Community calendar							
14.2.9. Surveys							
14.2.10. Peer rating of content							
14.2.11. Video Conferencing							
14.2.12. Learner to learner whiteboard							
14.2.13. Desktop sharing							
14.3. Provides infrastructure for coaching, mentoring, and other informal learning paradigms							
15. GAMIFICATION							
15.1. Badges							
15.2. Badge customization							
15.3. Points							
15.4. Rewards							
15.5. Levels							

REQUIREMENTS	Weight	[SPECIFY LMS 1]		[SPECIFY LMS 2]		[SPECIFY LMS 3]	
		Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
15.6. Leaderboards							
15.7. Customize Gamification mechanic							
16. THIRD-PARTY INTEGRATIONS							
16.1. CAS							
16.2. Adobe Connect							
16.3. Google Docs							
16.4. Google Calendar							
16.5. SharePoint							
16.6. Outlook, iCal, Google							
16.7. Skillsoft							
16.8. Twitter							
16.9. Skype							
16.10. SMS							
16.11. YouTube							
16.12. Vimeo							
16.13. LinkedIn							
16.14. Big Blue Button							
16.15. ExamView							
16.16. LaTex							
16.17. Flickr							
16.18. WebCT (Blackboard Vista)							
16.19. Blackboard							
16.20. Angel							
16.21. Moodle 1.9/2.x							
16.22. D2L							
16.23. Student Response Systems (e.g. TurningPoint Technologies)							
16.24. Zapier							
16.25. GoToMeeting							
16.26. WebEx							
16.27. GoToTraining							
16.28. Zoom							
16.29. MailChimp							
17. GOVERNMENT REGULATIONS							
17.1. Section 508							
17.2. Privacy Act							
18. INTEROPERABILITY STANDARDS & TECHNOLOGIES							
18.1. AICC							
18.2. Tin Can (xAPI)							
18.3. Single Sign-On (SSO) based on the SAML2 and LDAP standards							

REQUIREMENTS	Weight	[SPECIFY LMS 1]		[SPECIFY LMS 2]		[SPECIFY LMS 3]	
		Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
18.4. SCORM:							
18.4.1. Is certified or has been tested for conformance.							
18.4.2. Support all SCORM data model elements (SCORM 2004)							
18.4.3. Retains visibility for the TOC when a SCO has been launched							
18.4.4. Shows both — "attempted" status as well as —"completion."							
18.4.5. Is not overly proprietary in its implementation and handling of SCORM calls other than —attempted‖ and —completion."							
18.5. Supports multi-byte (Unicode) fonts (esp. Asian language characters) and right-to-left languages. This requires that the LMS interface text is stored as data, separate from source code.							
18.6. Offers flavors of the interface in foreign languages for global reach							
18.7. Supports the Training and Learning Architecture (TLA). See 5.12.7 Training and Learning Architecture (TLA)							
18.8. Active Directory							
Total			0		0		0