Mobile Assessment Technology in Army Schoolhouse Training

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ABSTRACT

In the U.S. Army Learning Concept for Training and Education 2020-2040, the Army recognizes the need for training/learning management improvements in order to enable education-based learning (U.S. Department of the Army, 2017). A mobile assessment tool called MLC SPOTLITE was developed for instructors of the Master Leader Course (MLC). This paper examines the usability and utility of MLC SPOTLITE as well as lessons learned from implementing new technology in the U.S. Army. MLC SPOTLITE was iteratively developed with input from and testing by MLC instructors, and was deployed on two-in-one devices. The development of MLC SPOTLITE aligned with several factors identified in previous research as facilitators of the use of technology to support the Army Learning Model, including an extensive front-end analysis, subject matter expert support, and editable software (Barnieu et al., 2016). The system streamlines the traditionally paper-based assessment process and allows instructors to digitally complete and sign course rubrics, and easily toggle between students. The majority of instructors found the system easy to use (94.8%), and all instructors agreed or strongly agreed that they felt confident using the system. Despite the need for such technologies to improve learning and education, there are significant challenges associated with using mobile devices in an Army setting. One challenge with using mobile technology is the variable access to Wi-Fi in Army classrooms. This paper explores and discusses some of the barriers that may prevent the wide-spread adoption of easy-to-use technologies. Without implementing mechanisms for overcoming such barriers, the role of technology in fulfilling the Army Learning Concept vision may be limited.

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INTRODUCTION

In their new roles as Master Sergeant, NCOs must shift their thinking from a tactical level to one more operational in nature; Master Sergeants must not only be technically proficient, but also must understand the artistry of managing and leading Soldiers (Portillo, 2014). Therefore, the U.S. Army implemented a new course in Non-Commissioned Officer (NCO) Professional Military Education called the Master Leader Course (MLC). The MLC bridges the Senior Leader Course (given to NCOs at the rank of E-7) and the Sergeants Major Course for E-9s. The approach used by USASMA to develop the MLC incorporated many of the principles identified in the U.S. Army Learning Concept for Training and Education 2020-2040 (ALC-TE, U.S. Department of the Army, 2017).

U.S. Army Learning Concept for Training and Education 2020-2040

The ALC-TE outlines a systematic approach to build future Army learning environments (U.S. Department of the Army, 2017). ALC-TE is organized around four major themes: 1) optimizing individual and collective learning, 2) improving learning infrastructure, 3) improving human capital development, and 4) leveraging sciences and technology (see Figure 1). The desired end-state is "an outcomes based, learner centric (adaptive), continuous and progressive learning environment that develops agile, adaptive, and innovative Soldiers and Army Civilians with the competencies required to build cohesive teams and successfully lead them in complex and chaotic operating environments" (U.S. Department of the Army, 2017, p. 19).

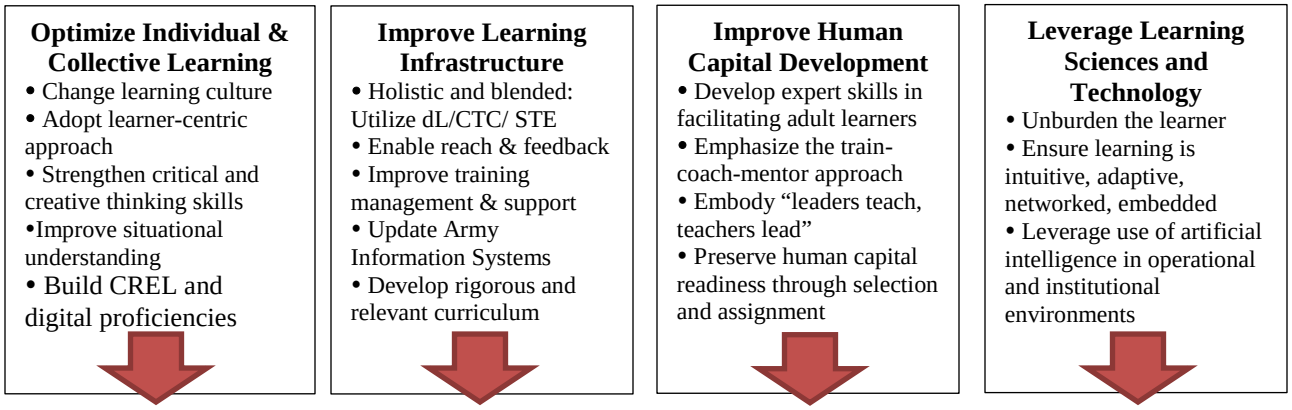

Figure 1. Four Themes of ALC-TE 2020-2040[1]

[1] CREL = Cultural Understanding, Regional Expertise, and Language Proficiency; dL = Distributed Learning; CTC = Combat Training Center; STE = Synthetic Training Environment

An important component of optimizing individual and collective learning identified in ALC-TE is identifying and assessing competencies and capturing and maintaining these data in an accessible information system. The second major theme of ALC-TE is improving learning infrastructure, which includes developing training management tools that meet the unique requirements of training and education. These principles guided the development of a mobile assessment tool for the MLC. In addition to the ALC-TE principles, the development of the mobile application was also guided by lessons learned from using technology in Army training and education.

Technology in Army Training and Education – Lessons Learned

Barnieu et al. (2016) examined the successes and challenges associated with implementing technology to meet Army Learning Model objectives. The researchers conducted a case study analysis of 21 technology products from seven Army Centers of Excellence and identified factors that facilitated or limited the effective use of technology in the Army classroom.

Barnieu et al. (2016) identified several factors that facilitated effective use of technology. First, a thorough front-end analysis coupled with on-going analyses during product development ensures that proper resources are identified, technical requirements are established, and the product meets the intent. Second, subject matter expert (SME) support and feedback throughout product development allows developers to make timely modifications. Third, editable software allows the user to maintain the product when changes are needed. Last, instructor training increases the use of the product.

Many of the factors Barnieu et al. (2016) identified as limiting the effectiveness of technology in the Army classroom were the opposite of the facilitating factors. Limiting factors include limited front-end analysis, limited SME access and/or support, software that is not editable, lack of instructor training, and lack of integration of the product into the program of instruction.

While Barnieu et al. (2016) examined factors that facilitate or limit technology implementation in the Army classroom in general, Wampler, Wolfe, Nihill, Bickley, and Reyes (2014) more specifically examined the use of mobile devices by Army instructors. For this research, instructors were outfitted with a tablet pre-loaded with several applications including Microsoft Office, audio, camera, e-mail, calendar, navigation, and several military applications. Overall, instructors had mixed reactions to the use of mobile devices in the classroom. Though some instructors saw the potential benefits of mobile devices, several factors that limit the utility of mobile technology were identified. First, access to Wi-Fi was often limited, reducing the ability to use the device. Second, some instructors experienced difficulty connecting to classroom equipment, such as printers and projectors. Third, the devices could not be used on the Army network and could not be connected to Army computers. Last, many instructors found the tablet functionality redundant with Army-issued laptops. That is, there was little added benefit to having a tablet in addition to a laptop.

FRONT END ANALYSIS

The Master Leader Course (MLC)

The Master Leader Course was developed for Master Sergeants and Sergeants First Class Promotable after a critical task site selection board identified skills and attributes for E-8s (Portillo, 2017).

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) worked with USASMA to identify users' needs with respect to technology. An extensive front-end analysis was conducted by interviewing course designers, instructors, and course leadership and conducting observations of pilot courses. The team examined the inclusion of technology for the purposes of reducing instructor workload without compromising data quality, quantity, or integrity. It quickly became evident that any technology intervention would have to fit the workflow of course instructors and support the required documentation and grading rubrics already used by course instructors without adding any unnecessary steps or procedures. The front end analysis identified specific opportunities to deliver technology that would enable mobility, flexibility, and information sharing with the primary goal of improving instructor efficiency and reducing time spent completing assessments. Many of the lessons learned from previous work examining technology in the Army classroom were implemented in the development of the mobile application tool for the MLC.

Front End Analysis Methodology

The research team used a combination of observations, interviews, and prototype demonstrations to establish requirements for the mobile assessment tool. While the primary function of the tool (e.g., present assessment material to instructors for each student) was known, the subtleties of what to measure, when to measure, and how to measure were not. In fact, they were still being developed as the research team began this project. The team also needed to identify any possible features and differentiate the *must have* from the *should have* and *could have* features. Establishing these primary and optional requirements enabled software developers to release working software iteratively with increasing functionality and improved adherence to users' needs.

Researchers observed portions of three course pilots (October 2015, December 2015, and February 2016). Each of the pilot courses were characterized by change, illustrating the dynamic nature of an evolving course of instruction. Changes included the number and format of the assessments and the order of administration. Consequently, each observation revealed different findings.

During each observation, researchers met with instructors and held discussions with course developers, the course manager, and USASMA leadership (henceforth, course personnel). Semi-structured interviews with instructors typically targeted pain points (e.g., "what challenges are you facing in this course?"). These questions often reveal opportunities for technology to reduce workload or enhance situational understanding. Course personnel were asked about the types of assessments used in MLC, the type of feedback provided to the students, how student performance was tracked, and how tablets might generally be used in the classroom. These questions helped researchers identify what content must, should, and could be included in the mobile assessment tool (e.g., required features and optional features). Questions also pointed to the timing and sequencing of events and assessments. The researcher attempted to establish any formalities with respect to timing or ordering of events in order to identify matching requirements in the tool. Time permitting, course personnel were also asked to discuss the competencies and attributes required for successful performance after completing MLC.

Front End Analysis Findings

Through the front end analysis, several requirements for the assessment tool were identified. Some of the requirements are common to any learning management system, such as being able to import or create a roster and GPA calculation. Other requirements were more unique to the Army environment or specific to MLC, such as rating each student on each assessment form (called 1009 forms), instructor login with Common Access Card (CAC), and student and instructor signature with CAC certificates. Two additional features were required to allow flexibility and sustainment of the tool in the future. First, GPA calculation is dynamic in that different forms can be used to calculate GPA based on the writing assignment used in a specific class. Second, an authoring tool was created that allows course developers to create new 1009 assessment rubrics when course content changes.

The MLC is a 14 day course and instructors must complete at least seven assessments (1009 forms) per student throughout the course. Each assessment focuses on a specific demonstrated ability, including contribution to group work, leadership, research ability, speaking and presentation, and writing. The majority of the course assessments must be completed in the final few days of the course. This means that instructors need an efficient way to complete and manage assessments. As can be seen in Table 1, several assessments are tied to specific days in the course (Days 7, 8, 10, and 11). Three assessments, which assess Leadership (1009L), Contributions to Group work (1009C), and Research Skills are not tied to one specific assignment and are typically completed toward the end of the course after the instructor has had sufficient opportunity to observe the particular competency.

Table 1. Example MLC Schedule

Day	Content	Assessment
1	Communication	
2	Communication, Leadership, & Management	
3	Management, Critical Thinking/Problem Solving	
4	Critical Thinking/Problem Solving; DOD Strategies	Practice Short Answer Essay
5	Joint Doctrine; Operational Art & Design	
6	Joint Intelligence Preparation of the Operational Environment (JIPOE); Joint Operations; Operational and Mission Variables	
7	Mission Command	Short Answer Essay (1009W - SAE)
8	Mission Command; Decisive Action	Research Paper (1009W – Individual)
9	Decisive Action	
10	Decisive Action	Group Briefing (1009S)
11	Military Decision Making Process	Short Answer Essay (1009W – SAE)
12	Military Decision Making Process	
13	Military Decision Making Process	
14	Graduation	

Device Selection

A two-in-one device was used to deliver the mobile assessment tool. The two-in-one was chosen for several reasons. First, it runs on the Windows operating system (OS). Developing the software for the Windows OS allows for integration with Army systems in the future. Second, because it is a two-in-one device, it can be used either as a laptop or a tablet. This flexibility meets instructor word processing, spreadsheet, and presentation needs. The detachable keyboard allows instructors to easily include written comments while using the device as a laptop and it can be useful for delivering a lecture or facilitating a discussion in tablet mode. Third, CAC certificate use was a requirement for this system. At the time of development, only Windows and iOS operating systems offered CAC certificate access. Finally, the two-in-one came at a reasonable per unit cost.

TOOL DEVELOPMENT

To develop the mobile assessment tool, MLC SPOTLITE, to fit the needs of the MLC course, an agile development methodology was employed. Agile is a process in which functional components of a system are developed and tested iteratively, reducing the need to rework missed requirements or untested functions. Compared to traditional software development, which assumes a fully specifiable problem and an optimal solution, agile software development methodologies focus on flexibility to address changes and meet user requirements (Dybå & Dingsøyr, 2008).

An agile approach enabled the development team to iteratively demonstrate, test, and develop increasingly sophisticated versions of the tool. Highest priority/*must have* features were designed and developed first. This ensured that regardless of future complications or failures, something could be delivered to the users. It also enabled actual testing rather than hypothetical testing. Users could input data into the system and extract data. Each iteration was followed by a demonstration and test. Tests took the form of functional validation (e.g., does the button do what it purports to do?) and user reactions. Results were formalized into change requests and new feature requests and folded into future development cycles (sprints) or tabled while higher priority items were addressed. Six iterations of the tool were released in this fashion, each offering additional features and variations in interaction, moving toward a more satisfactory finished product with each iteration.

Features

MLC SPOTLITE has a variety of features to support assessment and tracking of student progress. First, the student roster can be uploaded or manually entered into the tool. Once entered, all student names are easily available to the instructor. Once a specific student is selected, the list of assessments for that student will appear and the instructor can easily see what assessments have been started, completed, and/or signed. The instructor can also easily see how the student has performed on completed assessments. When an instructor selects a specific assessment, the instructor can

input the scores on the individual items within the rubric. The student's grade on the assessment is computed as data are entered. Instructors can also type in comments about overall performance. Data are saved automatically. The assessment can be left before it is complete and returned to later to complete. There is also a feature that allows for the reassessment of written assignments. If a student completes a reassessment, the two grades are averaged. The tool also includes a summary grade book which calculates GPA based on the MLC formula. Assessments can be printed or saved as PDFs. Instructors can also share assessments between devices using Bluetooth.

Another feature available to instructors is video tagging. Video tagging allows instructors to record performance, such as a brief or presentation using the device's camera and 'tag' moments the instructor might want to review with the student. Last, an authoring tool was developed so that course developers can create new rubrics as needed.

TOOL TESTING AND EVALUATION

MLC SPOTLITE was tested at six different course locations with 19 instructors. At each site, instructors were given a brief training on the tool and its features before the course began. Instructors were given an opportunity to try the tool, and researchers ensured the relevant roster and assessment forms were loaded in the tool before departing. The tools were left with instructors to use throughout the course. One or more members of the research team returned for the final few days of each course to provide support and help with troubleshooting as needed. The majority of the assessments were completed during the final days of the course, so the researchers were able to support the instructors when it was most needed without interfering with instruction. In addition to supporting the instructors, these visits provided an opportunity for the researchers to address issues as they arose, an important aspect of the agile software development process. Finally, these visits also gave the instructors an opportunity to provide feedback on the flow and features of the tool.

At the end of each course, instructors completed two surveys, one on usability and one on general satisfaction with the tool. Instructors also discussed issues with or ideas about the tool with researchers after completing the surveys.

System Usability Scale

The first instrument administered was the System Usability Scale (SUS), which is a simple, short, 10-item survey that can quickly indicate whether a tool or interface is acceptable to users (Brook, 1996). The scale consists of 10 items; five questions are framed positively, and five questions are framed negatively. Agreement is expected for the half that are positively framed, and disagreement is desired for the negatively framed items. The SUS has been validated and demonstrated to be a reliable indicator of user satisfaction, promoting confidence in design or instigating further investigation and redesign (Bangor, Kortum, & Miller, 2008). The scale is not diagnostic, as no specific design elements or functions of the tool are referenced. Instructors generally "agreed" or "strongly agreed" with the positively framed items (see Table 2). All instructors agreed or strongly agreed that they felt confident using the system and almost all instructors agreed or strongly agreed that the system was easy to use.

Table 2. Positive Valence Items from the System Usability Scale

Item	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
I felt confident using the system.	84.2 (16/19)	15.8 (3/19)	0	0
I think that I would like to use these display concepts frequently.	84.2 (16/19)	10.5 (2/19)	5.3 (1/19)	0
I thought the system was easy to use.	73.7 (14/19)	21.1 (4/19)	5.3 (1/19)	0
I found the various functions in the system to be well integrated.	73.7 (14/19)	15.8 (3/19)	0	10.5 (2/19)
I imagine that most people would learn to use this system very quickly.	68.4 (13/19)	26.3 (5/19)	5.3 (1/19)	0

Instructors generally "disagreed" or "strongly disagreed" with negatively framed items (see Table 3). Approximately one-third of instructors agreed that they need to learn a lot of things before using MLC SPOTLITE. Roughly 16% of instructors agreed that the system was unnecessarily complex, cumbersome, or that they would need technical support to use the system.

Table 3. Negative Valence Items from User Satisfaction Survey

Item	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
I needed to learn a lot of things before I could get going with this system.	0	32.6 (6/19)	5.3 (1/19)	63.2 (12/19)
I found the system to be unnecessarily complex.	0	15.8 (3/18)	10.5 (2/18)	68.4 (13/18)
I found the system to be very cumbersome to use.	0	15.8 (3/18)	10.5 (2/18)	68.4 (13/18)
I think that I would need the support of a technical person to be able to use the system.	0	15.8 (3/18)	31.6 (6/18)	47.4 (9/18)
I thought there was too much inconsistency in the system.	0	10.5 (2/18)	10.5 (2/18)	73.7 (14/18)

Usability Survey

To complement the general reactions to the tool obtained through the administration of the SUS, a second user experience survey was also administered to gather more specific information in relation to the tool's features and functionality. A set of standard heuristics defined by Jakob Nielsen and Rolf Molich (Molich & Nielsen, 1990; Nielsen, 1994; Nielsen, 1995; Nielsen & Mack, 1994) is traditionally accepted as a standard for usability evaluation. The heuristics are listed in Table 4. For each heuristic, one or more statements pertaining to the MLC SPOTLITE tool were developed. The usability survey included 31 items – 22 items were positively framed (e.g., I hardly ever made an error when using the MLC SPOTLITE tool) and nine items were framed negatively (e.g., Sometimes it was hard to remember how to use the tool). The usability statements referenced common features and operations of the tool framed from the user's perspective. As an example: "When I made an error, I always knew it" pertains to the first heuristic *Maintain visibility of system status through appropriate feedback*. Users responding positively to this statement indicated that they received good support and had the ability to manage their inputs effectively.

Table 4. Usability Heuristics Adopted from Nielsen (1994)

Usability Heuristics
Maintain visibility of system status through appropriate feedback
Ensure a match between the system and the real world to make information appear in a natural and logical order
Support user control and freedom through "undo" and "redo" functions
Maintain display consistency, standards and conventions
Design for error prevention to avoid error messages and resulting interactions
Design for recognition rather than recall
Use accelerators to ensure flexibility and efficiency of use for expert users
Strive for aesthetic and minimalist design, remove irrelevant or rarely needed information
Help users recognize, diagnose, and recover from errors
Provide help and documentation support

A total of 19 instructors completed the surveys. Overall, instructors tended to agree with the positive items (e.g., all instructors agreed to "I knew exactly where to go to capture an assessment" and "I knew where to go to view student and class results."). Instructors also tended to disagree with negative items (e.g., 95% of instructors disagreed with the statement "The interface had too much information on it."). However, this was not always the case. The positive items

with lower agreement (see Table 5) and the negative items with higher agreement (see Table 6) suggest areas for improvement. Accordingly, those are the items that are examined here.

It is worth noting that the positive valence item with the lowest level of agreement, "I hardly ever made an error when using the MLC SPOTLITE tool" still had a fairly high level of agreement, with the majority of instructors (63.2%) in agreement. The positively framed items with lower levels of agreement suggest that some instructors may have had less confidence using the tool – such as knowing when all assessments were complete or knowing the tool was saving their ratings. Some instructors reported making errors when using the SPOTLITE tool and were not always aware when they made an error. Approximately 20% of instructors also reported some difficulty learning how to use the roster to select a student.

Table 5. Positive Valence Items with Low Agreement

Item	Agree (%)	Disagree (%)	No Response (%)
I hardly ever made an error when using the MLC SPOTLITE tool.	63.2 (12/19)	31.6 (6/19)	5.3 (1/19)
I knew when all the outcomes and attributes had been assessed.	73.7 (14/19)	21.1 (4/19)	5.3 (1/19)
When I made an error, I always knew it.	73.7 (14/19)	15.8 (3/19)	10.5 (2/19)
It was clear to me that the tool was saving my ratings.	78.9 (15/19)	21.1 (4/19)	0

The negatively framed item with the highest level of agreement was "Sometimes, it was hard to remember how to use the tool," suggesting which 36.8% of instructors agreed with. The high agreement negative items suggest some issues remembering how to use or navigate the tool.

Table 6. Negative Valence Items with High Agreement

Item	Agree (%)	Disagree (%)	No Response (%)
Sometimes, it was hard to remember how to use the tool.	36.8 (7/19)	57.9 (11/19)	5.3 (1/19)
At times, I had trouble remembering where I was in the system.	21.1 (4/19)	78.9 (15/19)	0
I found that I made many errors when I completed an assessment for a student.	15.8 (3/19)	78.9 (15/19)	5.3 (1/19)

TOOL REFINEMENT

Following each iteration test, modifications and enhancements to the tool were identified, evaluated and incorporated into the development plan. The MLC SPOTLITE tool was developed following an iterative schedule of build, release and test. Its six iterations can best be characterized by increasing functionality. Each time the tool was deployed, the tested version had more, or different, features and was a closer representation of its final form; though it did have its setbacks. Worth noting is the dynamic nature of the MLC itself during development. The end of the pilot courses did not signal the end of course evolution. New and different assessment materials were being introduced right up until the end of tool development. This dynamic environment necessitated several changes to MLC SPOTLITE. One of note is the GPA computation. The researchers strove to offer a flexible tool that could adapt to a changing course, even after work was completed and developers moved on to other projects. As such, a GPA widget was initially developed. The widget was designed to enable users to select 1009 forms from the library and specify an algorithm for computing GPA (e.g., average of all 1009W form scores). GPA configurations could be saved and used until a change to the course dictated. However, this widget was abandoned after the fourth iteration when it was deemed too difficult to use and when course personnel gave assurances that the computation for GPA was set and would remain for the foreseeable future.

Following formal testing, the few remaining modifications or enhancements were addressed in a final development sprint and quality assurance testing cycle. Following that, the tool was ready for delivery and deployment.

TOOL DEPLOYMENT

After final testing and revision, the MLC SPOTLITE tool was transitioned to USASMA. The tool is currently in use in eight MLC course locations. An authoring tool was also developed to allow authorized personnel, such as course developers, to create new or revise existing assessment content for the tool. The authoring tool allows MLC SPOTLITE to be updated as changes are made to the MLC program of instruction.

DISCUSSION

The development of MLC SPOTLITE leveraged many of the facilitating factors identified by Barnieu et al. (2016) for implementing technology. First, the research team performed an extensive front-end analysis as the MLC was developed and pilot tested and conducted on-going analysis as the tool and the course developed. Second, the research team had access to subject matter experts, including the course developers and instructors throughout the development process. Third, the researchers trained instructors on how to use the tool. Last, the team developed an authoring tool, making the tool editable, which will allow qualified personnel to create new rubrics and edit existing rubrics as needed.

Overall, MLC SPOTLITE was well-received and fulfilled a need. The system streamlines the traditional paper-based assessment process, allows instructors to digitally complete and sign course rubrics, and to easily toggle between students. The majority of instructors found the system easy to use and all instructors agreed or strongly agreed that they felt confident using the system.

Despite the need for such technologies to improve learning and education, there are significant challenges associated with using mobile devices in the Army setting. For instance, rather than add another piece of equipment with the promise of making life easier but really adding workload, the MLC SPOTLITE tool sought to substitute the desktop computers instructors were expected to use. Selecting a two-in-one device with the Windows OS gave the instructors a mobile workstation, supporting classroom, office, and even home use, enabling instructors to complete their administrative duties with more flexibility. Further, the tool outputs assessment products in common formats such as .pdf and comma separated variables (.csv) which are formats commonly used by leading office software products installed on most computers in the Army network.

Another challenge with using mobile technology is the variable access to Wi-Fi in Army classrooms. Most classrooms where the MLC is taught do not have Wi-Fi access. Data extraction is performed manually, using compact discs. The standalone system does still support the sharing of information between users, a key *must have* from the team's initial requirements investigation. MLC SPOTLITE can provide its own ad-hoc networking capability through Bluetooth technology, allowing users to more quickly transmit data from one device to another. This feature enabled instructors to aggregate records on one device before making the disc transfer.

Many of the challenges associated with implementing technology in an Army classroom are consistent with the issues identified by Wampler et al. (2014) including compatibility with the Army network and network connectivity. These barriers may inhibit the wide-spread adoption of easy-to-use technologies such as SPOTLITE. The Army must continue to develop mechanisms for allowing technology solutions like the one described here to be more easily implemented and deployed. Without such solutions, it will become difficult to realize the benefits that such approaches to assessment can offer.

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