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The Usability of an Online Learning Management System in an Aviation Curriculum Blended Course Design: A Case Study

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The Aviation and Aerospace Science Department of Metropolitan State University of Denver has implemented a third-party Learning Management System (LMS) to standardize learning content in Aviation Fundamentals and Instrument Fundamentals, two core courses in the degree curriculum. Shifting primary content delivery to the online LMS allowed individual instructors to experiment with blended teaching techniques. In an effort to assess the usability of this course design, a survey of all student users was conducted. The findings presented in this article include data regarding the overall usability of the LMS system as well as student satisfaction and their preferences surrounding the blended format.

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Starting in the fall semester of 2012, the Aviation and Aerospace Science Department at Metropolitan State University of Denver (MSU Denver) adopted a web-based Learning Management System (LMS) provided by a commercial vendor to deliver course content for a lower-division core course, Aviation Fundamentals, which is required for all curriculum concentrations in the Department. This course serves two purposes: 1) to cover the aeronautical knowledge areas pertinent to private pilot certification, and 2) to provide an overview of core foundation level concepts in aviation for first year students. Given the significance of this course in the degree curriculum and the multiple sections of Aviation Fundamentals each semester, the LMS was introduced, in part, to improve standardization of course content. In the fall semester of 2013, a similar LMS was also adopted for Instrument Fundamentals, another lower division core course in the program that covers the aeronautical knowledge areas required for an instrument rating.

The implementation of the online training system in the Department was not intended to be in lieu of a classroom environment, but rather a blended experience that includes the student-instructor interaction in the classroom. The online training material managed through the LMS supplements the classroom experience, much like a textbook does. Unlike a textbook, however, the LMS records student progress through the course content. The LMS framework also allows instructors to assess the students' level of understanding of topics prior to meeting in class. This feedback provides the instructor with real-time information that can be used to adjust the lesson plan to better focus on deficient knowledge areas during class time. In addition, by moving a majority of the course content delivery to the web, instructors can utilize time spent in the classroom to work with students on application level exercises and discussions that reinforce the online content. This approach to instructional design, known as the inverted or flipped classroom, is rapidly gaining momentum in education (Millard, 2012; Tucker, 2012).

The purpose of this study was threefold: 1) to assess the usability of the LMS, 2) to gauge how well the LMS was being integrated into curriculum, and 3) to evaluate student perceptions and preferences concerning the course content delivered through the LMS. Data from this study show the online content is generally being well integrated into the course and students are benefitting from the use of the LMS as a means of improving retention of the course material. Additionally, students appreciate the engaging interactive aspects of the training material, which are images, graphics, animations and narration, as compared to traditional textbook formats.

While data from this study reflect the usability and format of this specific LMS, general themes with regard to aviation student preferences are identified. These themes offer a benchmark for programs looking to implement a similar system in their curriculum or develop their own online content to be used in a similar instructional design. These data are already being used by the MSU Denver Aviation and Aerospace Science Department to support a shift away from commercially available LMSs towards the development of in-house content. This includes leveraging readily accessible open educational resources (OER), such as the FAA handbooks, which reduces course material costs for the student.

Literature Review

Since the late 1980s "e-learning" has been expanding in many facets of aviation education (Kearns, 2010). Kearns (2010, p. 12) describes e-learning as "a shortened version of the term electronic learning. This method of training provides educational materials, computer-mediated communication (CMC), and the delivery of instructional content through electronic technology [citation omitted]. This electronic technology may take the form of the Internet or an organization's intranet."

A Learning Management System (LMS) is an instance of e-learning that facilitates content delivery and provides course management tools for instructors and administrators. One definition of an LMS describes the system as "software used for delivering, tracking and managing training/education. LMSs range from systems for managing training/educational records to software for distributing courses over the Internet and offering features for online collaboration" (Mahnegar, 2012, p. 148). "An LMS is a platform that allows an entire organization to manage, create, and track e-learning" (Kearns, 2010, p. 17). Further, an LMS "allows for teachers and administrators to track attendance, time on task, and student progress" (Mahnegar, 2012, p. 148).

There are only a few mentions in the aviation education literature of *usability* of or *satisfaction* with aviation education LMSs. In one example, reference is made to "satisfaction" of students regarding content of the Leadership in Aviation course at Griffith University that had been converted to online content. The only description of the measurement of *satisfaction* is in response to the question, "This course engaged me in learning," but no statistics were given quantitative measurement (Kille, Bates, & Murray, 2015, p. 88).

The subjects of both *usability* and *satisfaction* of students using an LMS in an online course for the aviation doctoral program at Embry-Riddle Aeronautical University are mentioned in Neal & Hampton (2016). However, the subject of *usability* is limited to describing how setting up the course contains several issues, among them being "…internet technologies carrying unforeseen usability difficulties" (Neal & Hampton, 2016, p. 8). The subject of *satisfaction* in the course was measured by a survey item: "How likely is it that you will recommend this course to another student?" (Neal & Hampton, 2016, p. 27).

In recent work, Kearns, Mavin, & Hodge (2016) describe the typical use of LMSs in college and university aviation education environments as a component of "blended learning," in which web-based LMSs "support classroom teaching through a portal that learners and instructors use to distribute messages, media, grades and other classroom materials" (p. 140). In this work, there is no discussion of usability or satisfaction of LMS systems.

In a broad context, our study's emphasis on *usability* of the LMS fits into the *summative* evaluation category described by Kearns (2010), what she describes as "each learner's positive or negative feelings toward training" (p. 156). However, her discussion contains no specific focus on *usability* issues, such as those formulated by Brooke (1996).

In very recent work, Dusenberry and Olson (2019) explored the impact of "flipped learning" (a form of blended learning) on student perceptions and academic performance. The study was conducted with a small case group of eighty-one students studying human factors in aviation comparing subgroups of flipped learning students and traditional lecture students. Their study results indicated the flipped learning group did not perform better than the lecture group, and that the lecture group reported higher overall course satisfaction (Dusenberry & Olson, 2019).

Aside from aviation-specific studies, the review of the literature did not uncover many general studies evaluating student attitudes and satisfaction of LMS environments measured with the System Usability Scale (SUS) questionnaire. In a limited meta-review, Orfanou, Tselios, and Katsanos (2015) found a mere eleven studies in which students were surveyed on the usability of LMS environments. The SUS questionnaire was used to survey more than 750 students across the eleven studies reviewed. These studies evaluated the usability of two similar LMS platforms (Moodle and eClass) to the LMS platform Blackboard

Method

To evaluate the student perception of the online learning experience using an LMS platform, a survey was developed and handed out to students each semester, which was deemed exempt from IRB review. The surveys were conducted during the last four weeks of the regular 16-week semester for each Aviation Fundamentals and Instrument Fundamentals sections being offered. Instructors administered these surveys to the students during regular class time. Soliciting student responses at least 12 weeks into the semester gave the students sufficient opportunity to interact with the online system and develop experience with the software beyond an introductory level. The surveys allowed students to anonymously reflect upon their experience with the online system up to that point in the semester and provide feedback of their experience using the software. Data from the surveys were gathered for all spring and fall semesters between fall 2012 and spring 2017. During the fall 2012, spring 2013 and fall 2013 semesters, modifications to the surveys were made, as questions and statements were included to capture additional information with regards to declared majors and overall system usability. The survey stabilized for the 2014 academic year, but due to the earlier additions and modifications, some of the feedback gathered does not reflect this entire timeline. In addition, several questions on the survey pertained directly to administrative curriculum details that are outside the scope of this study and are therefore not included.

System Usability Scale Test

A System Usability Scale test was incorporated into the survey to assess students' perception regarding general usability of the LMS, referred to in the survey as the online training system. The SUS score is a benchmark rating for assessing, by the user group, the usability of a system that requires human interaction (Brooke, 1996). SUS tests are not specific to any one particular technology, and as such have been employed to generate usability benchmarks for a broad spectrum of products (Kortum & Bangor, 2013). Quantifying usability for the LMS was a revealing exercise for this case study. A student's capability to interact successfully with the online training system in an efficient and satisfactory manner can, to some degree, be inferred

from the system's usability (International Organization for Standards [ISO], 1998). A low usability score in this case study would suggest dissatisfaction with the product interaction, possibly due to systemic problems with the LMS design and/or implementation. A high usability score, however, would only suggest user satisfaction regarding interaction with the LMS. In either case, further feedback from the students is required in order to reveal a more in-depth perspective on student satisfaction with the overall implementation.

The SUS test used in this study is shown in Figure 1 and was modified from Brooke (1996). Statement numbers 1, 4, and 5 were slightly modified from the original to directly address the LMS. Simple modifications to the SUS statements have been shown not to affect the usability scoring results (Bangor, Kortum & Miller, 2008; Sauro, 2011).

In the original Brooke (1996) SUS test, statement 1 was: "I think I would like to use this system frequently." Since the purpose of the online training system for Aviation Fundamentals and Instrument Fundamentals is to deliver content material and assess the student understanding of that material, the more appropriate statement: "I believe the online training system helps me better understand the course material" was used to take into account the goal of the system. Statement 4 was modified from "I think that I would need the support of a technical person to be able to use this system" to "I could have used more training on how to use the online system." Again, the original statement as worded is too generic and does not reflect the context of the instructor-student relationship for this application. Finally, statement 5 was also modified to reflect the integration of the LMS with the traditional in-person course offering. The original statement in the Brooke (1996) SUS test is: "I found the various functions in this system were well integrated" was changed to "I found the various ground lessons in this system were well integrated with the course." The content of the online training system is organized into modules called "ground lessons," which are referenced by the students.

Open-Ended Answer Survey Questions

The elements of system usability, as outlined in ISO (1998), pertain to a user being able to achieve a stated goal through performing tasks, or activities, within the context of a system. These elements are 1) *effectiveness* – the ability to achieve goals, 2) *efficiency* - the expenditure of time and resources in performing tasks to achieve goals, and 3) *satisfaction* - the extent to which the user finds the product acceptable in achieving goals (ISO, 1998). In the context of the online training system discussed here, the goal of this implementation is content delivery of aeronautical knowledge areas in an environment outside the classroom setting. The ground lesson modules and assessments of the LMS are the structure by which this goal is achieved. In the ISO (1998) recommendations for usability analysis, user perception can provide an indication as to the efficiency and satisfaction of interacting with the system being evaluated. Learner perspectives, on the other hand, are not considered direct measures of effectiveness (Means, Toyama, Murphy & Baki, 2013). Positive and negative comments from the user group can therefore reveal efficiency issues, which relate to the time to complete tasks, in addition to overall satisfaction, which reflects user attitudes towards the product (ISO, 1998).

To capture student perceptions as they pertain to usability, the survey posed two questions requiring an open-ended written response from the participants (see Figure 2). These

two questions allowed the student to share positive and negative comments of their experience using the system. The written responses to these questions were categorized into common themes (see Table 1).

1.	I believe the online training system helps me better understand the course material: (*modified*)				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
2.	I found the online training system unnecessarily complex.				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
3.	I thought the online training system was easy to use.				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
4.	I could have used more training on how to use the online system. (*modified*)				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
5.	I found the various ground lessons in this system were well integrated with the course. (*modified*)				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
6.	I thought there was too much inconsistency in this online training system.				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
7.	I would imagine that most people would learn to use the online system very quickly.				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
8.	I found the online training system very cumbersome to use.				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
9.	I felt very confident using the online training system.				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
10.	I needed to learn a lot of things before I could get going with this online training system.				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Figure 1. Modified System Usability Scale (SUS) Test based on Brooke (1996)

- What aspect of the online training system did you find the **most** useful?
- What aspect of the online training system did you find the **least** useful?

Figure 2. Open-ended survey questions

Table 1
Student Feedback

Usability Element	*Theme*	*Description*
Satisfaction	Interface	Comments pertaining to the interface design.
	Presentation	Comments pertaining to the presentation, animations, audio and videos.
	Assessments	Comments pertaining to quizzes, exams, and other assessment tools provided.
	Content	Comments pertaining to the lesson material.
Efficiency	Performance	Comments pertaining to the efficiency and ease of use.
	Accessibility	Comments pertaining to the readily accessible content in an online training environment.
	Repetitive	Comments pertaining to the redundancy between class and online content.
	Length	Comments pertaining to time on task.

Likert-item Survey Statements

The survey recorded Likert-item responses to two general statements regarding the student experiences and perceptions using the online system. Additionally, the responses to two specific SUS statements were analyzed. These questions, presented in Figure 3, were intended to gauge student reaction to the desirability of employing similar systems in other core curriculum classes.

For each statement in Figure 3, the Likert-item responses included five options: *Strongly Disagree*, *Disagree*, *Neither Agree nor Disagree*, *Agree*, and *Strongly Agree*. The option of *Neither Agree nor Disagree* alleviates the need to state a level of agreement or disagreement with the question posed when students did not feel strongly one way or the other. Students who selected *Strongly Disagree* or *Disagree* rejected that particular statement in the survey while the students who selected *Strongly Agree* or *Agree* accepted the statement.

- I would like to see more aviation classes adopt an online training system.
- I prefer to use the online training system rather than the textbook.
- I believe the online training system helps me better understand the course material. (SUS statement 1)
- I found the various ground lessons in this system were well integrated with the course. (SUS statement 5)

Figure 3. Likert-item survey statements to gather general student feedback about utilizing the LMS.

Results

The particular LMS used by MSU Denver remained largely static throughout the survey period in both the content presented as well as the system architecture and appearance. While an

evaluation of year-to-year feedback was completed as part of the data analysis, the yearly trends are generally similar. For this reason and for the simplicity of the data representation, the results presented below have been aggregated across the entire span of the surveyed semesters.

SUS Test Results

The results from the SUS test on the student surveys from spring 2013 through spring 2017 were converted into SUS scores. For a discussion on how to arrive at a SUS score when analyzing the SUS test results, refer to Brooke (1996).

Figure 4 shows the distribution of the SUS scores for this study using a box plot, which represents data quartiles using the 25th, 50th, and 75th percentile ranges. The central box represents the "inter-quartile range" and represents the central 50% of the data (Krzywinski, 2014). According to Krzywinski (2014), a box plot is preferred for data distributions which are not symmetrical or do not contain significant outliers.

The mean SUS score for the LMS in this study was 67.5 with a range from 10 to 100. SUS scores in the high 50s and 60s are generally considered marginal usability scores (Bangor et al., 2008). However, Bangor et al. (2008) also found that the mean SUS score from multiple surveys conducted specifically on web-based applications was 68.05 with a standard deviation of 21.56 (n=1180). Sauro (2011) also points out that the average SUS score from almost 500 studies with over 5,000 participants and encompassing a wide variety of systems was 68. For the LMS in this study, the average SUS score of 67.5 was just below average on the usability scale and well within one standard deviation of the web-based applications' average SUS score (Bangor et al., 2008). These findings suggest that the online training system's usability is in line with the results from other web-based applications that have been surveyed with the SUS test. This marginal SUS score, however, is not revealing one way or the other concerning student satisfaction.

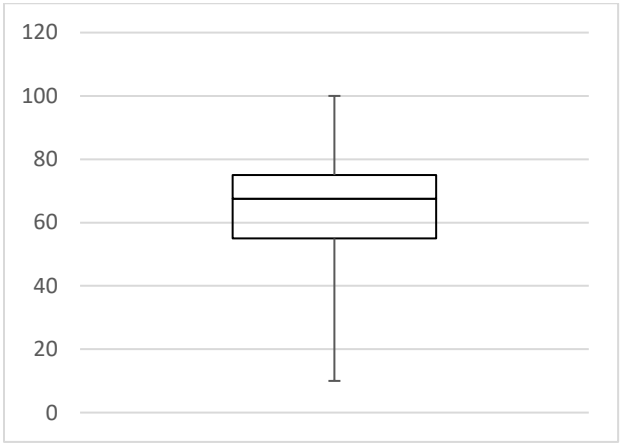

Figure 4. The box plot of SUS Scores for the online training system (N=610).

Open-Ended Survey Results

The results in Figure 5 show what students found to be the most useful with the online training system. The top three most useful aspects identified were: 1) presentation, 2) content and

3) assessments. These three categories accounted for 524 of the total 614 responses, or approximately 85%.

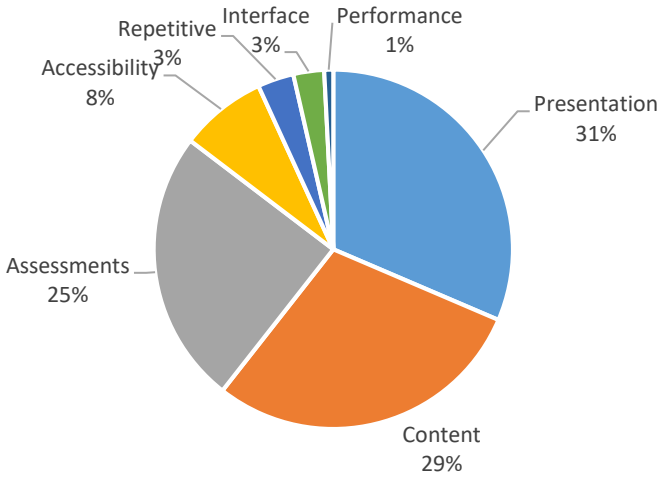

Figure 5. Student responses to the question: "What aspect of the online training system did you find the **most** useful?" (*N*=614).

The results in Figure 6 are the categorized student responses to the question: "What aspect of the online training system did you find the least useful?" Of the 526 responses submitted for this question, 158 (30%) indicated that the length of the lessons was least useful. One of the key issues identified early in the adoption of the online training system was the length of the individual ground lessons, or time on task efficiency (King & Duburguet, 2013). Tucker (2012) suggests that online content should explain concepts in clear and concise chunks in order not to exceed a student's attention span. The sample videos highlighted by Tucker (2012) are 4-6 minutes in duration. Evaluating the time spent by the students on every individual lesson attempted in the current study, the mean ground lesson time was 1 hour 3 minutes for the Aviation Fundamentals course and 36 minutes for the Instrument Fundamentals course. A logical conclusion is that the LMS lessons are longer than ideal.

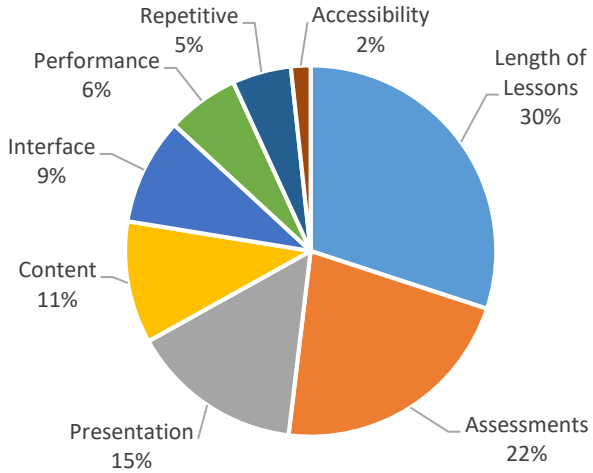

Figure 6. Student responses to the question: "What aspect of the online training system did you find the **least** useful?" (*N*=526)

The top three categories respondents found *most* useful (assessments, presentation and content) corresponded with three of the top four categories they found *least* useful. To explore this discrepancy, the open-ended responses were evaluated more closely, and where respondents provided sufficient explanation, sub-themes within each response category were determined. If a sub-category could not be determined, the response was categorized as "other."

Presentation Category

Among the respondents who found the presentation most useful, 59% (*n*=130) enjoyed the format and visual aspects of the online training. Having the lessons in video format with graphics, images and animations seemed to enhance usability. The second most useful aspect of the presentation was the voice narration of the lesson content, garnering 10% of the responses (*n*=19). While these students appreciated the inclusion of the narration, a majority of the least useful comments pertaining to presentation identified narration as the source of their dissatisfaction. The "boring" or "monotone" nature of the narrator's voice was commented on by 51% of respondents (*n*=49). An additional 11% of respondents (*n*=9) did not directly reference the narration but indicated the lessons as a whole were "boring" or "dull." One could argue that these responses also speak to the narration since it is a significant portion of the presentation. The detailed breakdown of sub-categories related to presentation are shown in Figures 7 and 8.

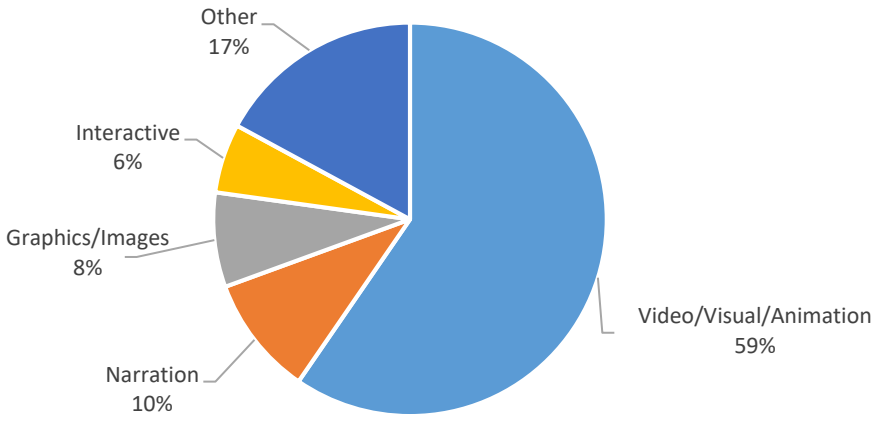

Figure 7. Sub-categories for respondents indicating *presentation* as the **most** useful element of the LMS. (*n*=160)

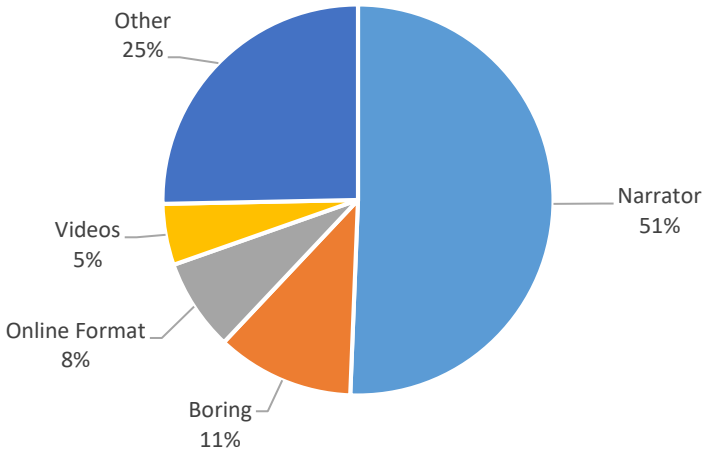

Figure 8. Sub-categories for respondents indicating *presentation* as the **least** useful element of the LMS. (*n*=79)

Content Category

Evaluating the *content* category, 27% (*n*=48) of respondents who found the content most useful identified the level of detail and thoroughness of the information provided, and 10% (n=18) thought it was explained well. Additionally, 18% (*n*=32) of the respondents believed the LMS content served as a good supplement (either preparation or review) to the material presented in class. The respondents who indicated the content was least useful identified the presence of maneuver and flight lessons included throughout the online course. These elements of the LMS were not used in the MSU Denver course curriculum and the LMS did not provide administrative functionality to remove these modules from the main course content display. Some students expressed their dislike of the system as a whole, with 16% (*n*=9) identifying "all of [the content]" least useful. The detailed breakdown of sub-categories related to content are shown in Figures 9 and 10.

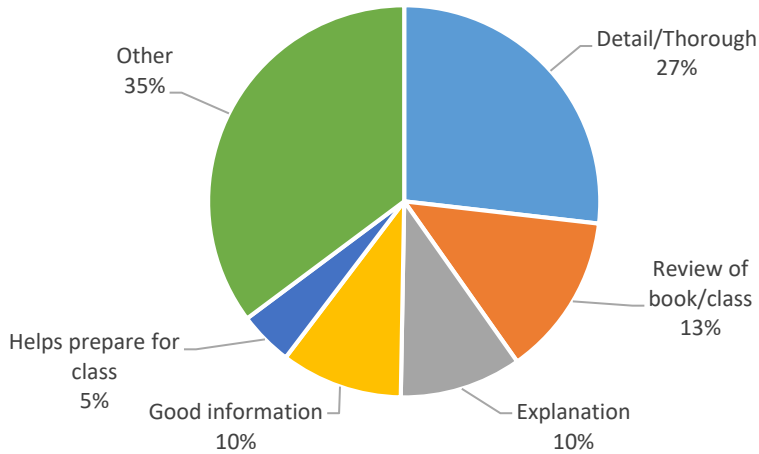

Figure 9. Sub-categories for respondents indicating *content* as the **most** useful element of the LMS. (*n*=179)

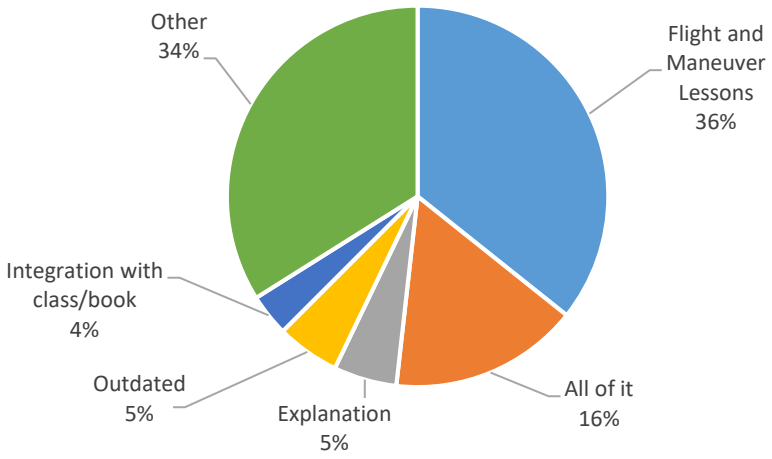

Figure 10. Sub-categories for respondents indicating *content* as the **least** useful element of the LMS. (*n*=56)

Assessment Category

Detailed results within the *assessment* category primarily appear to indicate differences with instructor facilitation of the course and general student preference towards assessments. Among the students who found the assessments least useful, 14% (*n*=16) were unable to review the questions answered correctly and incorrectly on the exams. While this functionality does exist in the LMS, the interface does not didactically lead the user to the review, so many students were unaware of this feature. For students who were aware of this functionality, either because their instructor demonstrated it in-class or they came across it on their own, 16% (*n*=25) found it to be the most useful element of the LMS. Other themes found among students who found assessments most useful included short, low-stakes, practice exams in the lesson (13%, *n*=19), the ability to re-take failed exams (11%, *n*=17), and the frequency of exams (11%, *n*=16). Among students who found the assessments least useful, 17% (*n*=19) identified the frequency of exams, 12% (*n*=14) took issue with the exam durations, and 9% (*n*=10) found the exams too difficult. The detailed breakdown of sub-categories related to assessments are shown in Figures 11 and 12.

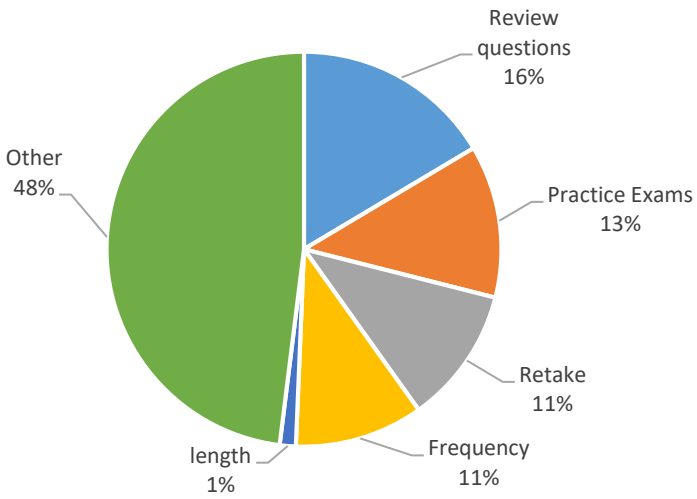

Figure 11. Sub-categories for respondents indicating "assessments" as the **most** useful element of the LMS. (*n*=152)

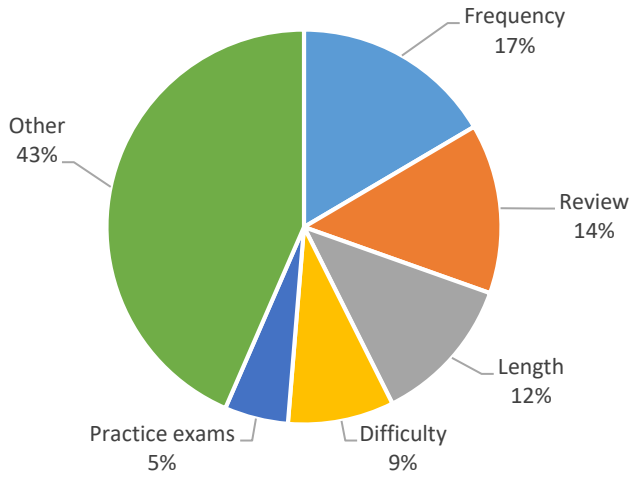

Figure 12. Sub-categories for respondents indicating "assessments" as the **least** useful element of the LMS. (*n*=115)

Likert-item Survey Statement Results

From the 713 student responses to the question, "I would like to see more aviation classes adopt an online training system," 35% (*n*=252) agreed with this statement, 32% (*n*=228) neither agreed nor disagreed, and 33% (*n*=233) disagreed (see Figure 13). In addition, of the students who agreed with this statement, only 6% (*n*=45) strongly agreed, while of the students who disagreed, 14% (*n*=102) strongly disagreed. Given the ordinal nature of Likert-item data, it is not possible to quantify to what degree strongly disagreeing and strongly agreeing differs from disagreeing and agreeing, respectively (Cooper & Johnson, 2016). What can be inferred, however, is that of the students who disagreed with the statement in Figure 13, a larger percentage felt strongly about it compared with those students who were in agreement.

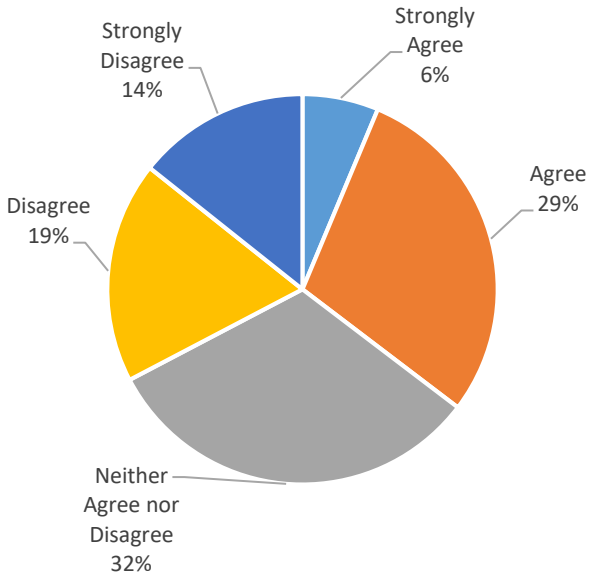

Figure 13. Student responses to the statement: "I would like to see more aviation courses adopt an online training system." (*N*=713)

Of the 616 student responses to the question, "I prefer to use the online training system rather than the textbook," 40% (*n*=249) agreed with this statement, 23% (*n*=143) neither agreed nor disagreed, and 36% (*n*=224) disagreed (see Figure 14). Once again, the number of students strongly disagreeing (16%) exceeded the number of students strongly agreeing (10%).

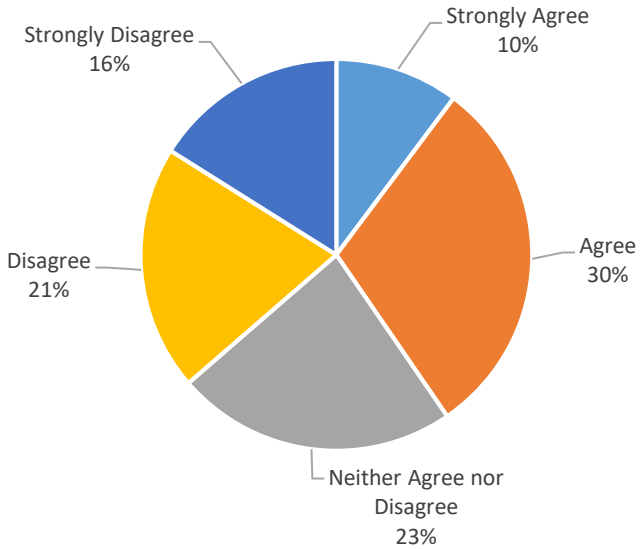

Figure 14. Student responses to the statement: "I prefer to use the online training system rather than the textbook." (*N*=616)

Of the 702 student responses to the SUS question, "I believe the online training system helps me better understand the course material," 66% (*n*=458) agreed with this statement, 18% (*n*=126) neither agreed nor disagreed, and 17% (*n*=118) disagreed (see Figure 15). In a reversal, students felt more strongly in agreement to this statement with 16% (*n*=109) strongly agreeing and only 4% (*n*=31) strongly disagreeing.

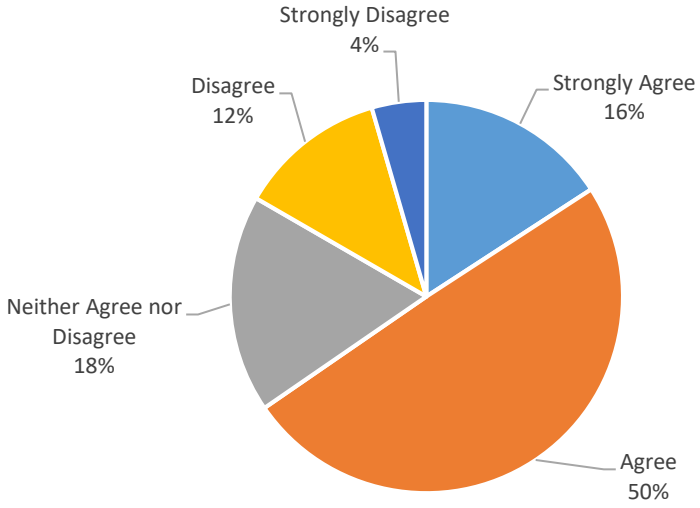

Figure 15. Student responses to the statement: "I believe the online training system helps me better understand the course material." (N=702)

Finally, of the 616 student responses to the SUS question, "I found the various ground lessons in this system were well integrated with the course," 75% (*n*=461) agreed with this statement, 16% (*n*=100) neither agreed nor disagreed, and 9% (*n*=55) disagreed (see Figure 16). Similar to the previous question, students generally felt more strongly in support of this statement, with 16% (*n*=100) strongly agreeing and only 3% (*n*=19) strongly disagreeing.

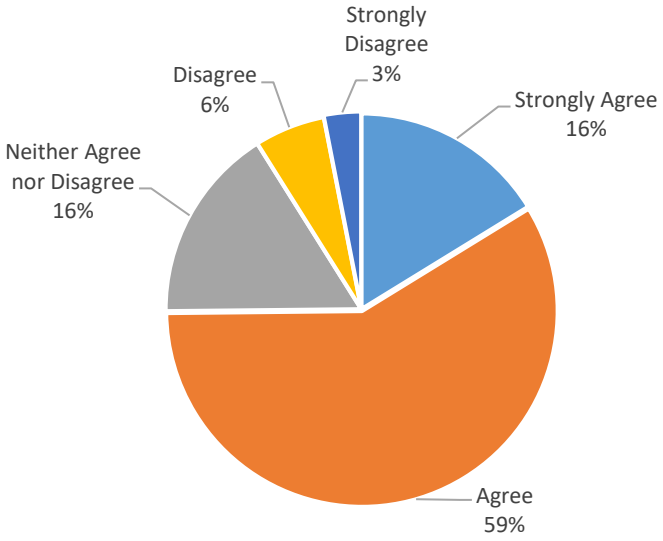

Figure 16. Student responses to the statement: "I found the various ground lessons in this system were well integrated with the course." (*N*=616)

Discussion

The results of the survey suggest a lack of resounding user satisfaction with the LMS by the student group, but do point to areas of improvement that can be made in the course experience. Students showed support for the use of the LMS as a means of improving their understanding of the course material. In this regard, they considered the material to be well

integrated into the course as a whole. Conversely, the student response seemed to also indicate a preference for not applying the use of an LMS to other courses in the program. This sentiment may be rooted in the out-of-pocket expense to access the online content. Some open-ended written responses indicate a dissatisfaction with the expense of a third-party solution. In addition, the lack of administrative tools to customize the online content access meant that students could view ancillary content that was not required by the course syllabus.

Some of the survey feedback highlighted differences with individual instructor implementation of the learning management system in the course. Instructors facilitating the surveyed course sections had previous experience with the course content and delivery in more traditional in-class environments. However, the blended learning format were relatively new, so there may have been a tendency to revert to conventional presentation methods during the scheduled class sessions. Student comments indicating that the online material was "redundant" with their time spent in class suggest that some instructors were not fully implementing a blended learning approach. In addition, the responses indicating the online content served as a good "review of the class" suggest some students were viewing content following the associated in-class sessions instead of prior to it, as was intended. Although the blended learning strategy was not mandated in the course curriculum, the intent of the LMS was, in part, to provide instructors with a framework to explore this approach. Instructors teaching these courses, however, ultimately decide how to implement the online tools in their classes. These factors, taken together or separately, could be a strong contributing factor to the survey results summarized above.

Because this study was designed as a case study, it remains as a future exercise to design a standard curriculum for these courses to take advantage of the concepts of the blended learning environment. This includes education and guidance for instructors who teach these courses, and the development of standard classroom activities to apply the concepts presented in the online portion of the course to real-world scenarios. The results of survey questions to measure the overall satisfaction levels and student attitudes on usability of the LMS could be analyzed by section (i.e., individual instructor) and then correlated with the in-class assignments and activities developed for those sections. It is reasonable to assume that patterns would emerge from the data that show differences among student perceptions of the qualities of the online system that can be related to the use of the standardized materials provided to both help simplify the use of the system and reinforce the learning experience on the part of the student.

Where the data from this study have been most influential has been in the development of in-house content as an alternative to an offering from the third-party provider. The shift to in-house content will benefit the Department's objectives by allowing more control over the content of the material and the delivery mechanism, as well as the delivery schedule. Further, it will benefit students by being distributed free of charge through the University's supported learning management system (Blackboard), helping to reduce out-of-pocket costs. Additionally, it will allow the integration of OER texts from the Federal Aviation Administration and other sources to support the online learning and in-class content. The themes identified in the data for this survey have already begun shaping the format of in-house content for other course offerings at MSU Denver (*Commercial Flight Operations* and *Aviation Weather*), spanning various course formats (online and in-person). Following stabilization of these course formats, additional studies are

planned to compare their results to this study and evaluate user perceptions with more targeted and affordable content.

The aviation students surveyed in this study identified the overall format of the lessons, including video, graphics and images in lieu of static text to be useful features of the online training. Additionally, voice narration of the content seemed generally well received, but care should be taken to select narration with acceptable inflection or enthusiasm, and limit the length of lessons to keep it from seeming monotonous. Different narrator voices and/or having the ability to mute the narration altogether are features that could also address these student concerns. If selecting a commercially available system, consideration should also be given to the complete package being offered. Offerings that contain material not utilized in the coursework should be avoided when possible to avoid the impression among students that they are paying for content from which they receive little to no value. Administrative tools that allow customization of the online course design to meet the specific needs of the class curriculum should also be available.

Conclusion and Future Considerations

The results of this case study reveal interesting and valuable information regarding the continued use of the LMS as the course content delivery platform for aviation coursework. There are limitations to this research that have been identified. Limitations include the lack of significant historical data of LMS environments that have been evaluated using SUS, the inability to make comparisons with existing research studies, and limitations consistent with using a case study methodology.

Discovered during the review of the literature, the lack of substantial research studies using SUS survey techniques of aviation student attitudes and satisfaction with LMS learning environments did not provide a foundation for developing the data collection strategies. This limitation also did not allow for meaningful comparison of this study's data to previous research study data. While not substantial, these limitations restrict comparisons and interpretations to the data sets collected and associated with this study's efforts. Additionally, given the case study methodology applied, the data collected does not allow for generalization to a given population, rather only for the study's participants and the aviation students of the program as a whole. However, this is wholly consistent with case study research and actually can be considered a benefit of this study's results.

There are several good areas for future research and exploration. These areas include continued survey of student attitudes and satisfaction with LMS environments, comparisons of current third party LMS and custom in-house LMS environments, potential improvements in designing blended learning activities to facilitate student use of LMS course content, and expanding future studies to include supplementing the SUS survey with additional survey data to include qualitative data sets, and the development of surveys that could produce data sets that may address student attitudes and satisfaction with the efficiency of learning via LMS learning environments.

As this study was designed as a case study approach, the data results offered good insight into students' attitudes and satisfaction regarding the use of the LMS environment. This study identified both positive aspects of using the LMS, as well as aspects of the LMS environment that could be improved upon. These discoveries serve well for the continued use of the LMS environment in a blended learning approach, for areas where the LMS environment could be enhanced and perfected to improve the students' satisfaction, as well as moving forward in designing new in-house LMS-based content for other aviation course content for the Department's programs.

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