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The purpose of this study was to explore if flipped learning has an impact on aviation students perceptions and academic performance in a human factors course. A total of 81 students from a large Midwestern university participated. The Course Evaluation Survey (CES) was used to measure student perceptions, while course exams were used to measure academic performance. To analyze the data, the researchers use paired sample *t*-tests, independent sample *t*-tests, and a MANCOVA. Findings show students in the flipped classroom did not perform better than the lecture classroom. In addition, students in the lecture group had significantly higher overall course satisfaction. These findings suggest students are familiar with lecture and changing the pedagogical approach is more nuanced, requiring students more time to adjust.

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Located in a small rural community in Colorado is Woodland Park High School. Related to its remote location, student athletes are required to travel to other schools to compete in athletics; the consequence of this requirement is that students miss considerable class time for lengthy travel times. In response, Jonathan Bergmann and Aaron Sams, chemistry teachers at Woodland Park, decided to flip their classrooms. Bergmann and Sams (2014) define flipped learning as "…direct instruction delivered to the individual outside of class, and more strategic use of in-class time for group work and individualized attention" (p. xi). Their impression was that flipped learning was more engaging and that deeper learning occurred, asserting that flipped learning is a viable learning approach.

Woodland Park High School was not the only success story related to flipping the classroom. Clintondale High School, located in Detroit, Michigan, had high failure rates, many discipline issues, and a number of parental complaints. In 2010, the school's principal, Greg Green, decided that drastic change was needed. In 2011, Green flipped all freshman classes, and based on the success, flipped the classes in the entire high school in 2012. The results at Clintondale High School were as follows: failure rates dropped by 30%, discipline cases dropped 74%, and parental complaints virtually disappeared. Data clearly showed students at Clintondale High School responded to the pedagogical change of flipping the classroom (Green, 2012). Because of Woodland Park and Clintondale High School successes, flipped learning has gained national attention and is a growing part of the dialogue among educators at all levels. A survey of faculty by the Center for Digital Education and Sonic Foundry revealed that 29 percent are using the flipped classroom model, and 27 percent plan to use it within the next 12 months (Bart, 2013). Flipping the classroom is changing the national conversation regarding education. The shift from a teacher-centered to a student-centered classroom is underway.

Background

It is important to understand what a flipped classroom is before discussing the broader aspects and implications. The flipped classroom is:

> …a model of learning that rearranges how time is spent both in and out of class to shift ownership of learning from the educators to the students. In the flipped classroom model, valuable class time is devoted to higher cognitive, more active, project-based learning where students work together (*NMC Horizon Report*, 2015, p. 38).

Students arrive for class having watched the recorded lecture and completed the assigned material. During class time, students use their newly acquired knowledge actively, which gives them the opportunity to reinforce and apply the information. The key piece is not the particular activity selected in class; rather, it is that class time is student-centered and active. This broader understanding of learning leads to the two parts of flipped learning.

The Two Parts of Flipped Learning

Flipped learning combines the positive aspects of lecture with the benefits of active learning, which makes flipped learning effective and student-centered. The lecture addresses factual knowledge, while active learning promotes comprehension and application (Kavous Ardalan, 2008; McKeachie, 1990).

Lecture. Even as calls for more active learning have been recommended (Prince, 2004), studies such as Watts and Schaur's (2011) national survey of economists shows that direct instruction (lecture) remains the dominant method of instructional delivery. They examined four surveys from 1995 to 2005, and noted that direct instruction was the leading form of delivery (i.e., reported 83% of time spent lecturing). The lecture remains the favorite choice among faculty to deliver instruction in higher education.

The research shows lecture is a good way to transfer facts, yet inadequate when it comes to promoting discussion and deeper thought (Bligh, 1998). The purpose of lectures should be to acquire knowledge and facts, and then apply that knowledge by actively using it in the classroom or lab. It is not a question of whether lecturing is good or bad, but where and how it should be utilized (Burgan, 2006). Flipped learning connects the lecture to active learning, which promotes learning.

Active Learning. Chickering and Gamson (1987) brought active learning to the forefront when they listed active learning as one of the seven principles of good teaching in undergraduate education. A more recent call for active learning was made by The President's Council of Advisors on Science and Technology (PCAST) to engage students and increase retention rates (Olson & Riordan, 2012). The traditional paradigm in higher education has students sitting in large classrooms, listening to, and hopefully assimilating the knowledge and information the lecturer is presenting. Active learning shifts this paradigm by putting the student at the center of learning, not the instructor. This shift to student-centered learning in higher education makes learning more experiential, which facilitates higher level critical thinking. Active learning places learning in the hands of the students, and the educators become the guides.

Flipped learning connects the acquisition of knowledge and facts through lecture, to active learning in the classroom. Flipped learning is changing the way education is approached, and providing a new way to utilize the time-tested and popular approach to teaching, the lecture.

The popularity of the flipped classroom and body of research findings--albeit small and largely anecdotal--gives hope that this pedagogical approach may be a solution. Yet, as Millman (2012) says, "…no empirical research exists to substantiate its use, anecdotal reports by many instructors maintain it can be used at any education level…" (p. 86). This statement suggests that research must empirically validate that flipping the classroom improves student learning, and cultivates the development of critical thinking skills and dispositions. This gap in the literature was the impetus for this study.

The researchers attempted to answer two research questions:

1) Do students in a flipped learning course perform better academically than students in a lecture course?
2) Do students' perceptions of flipped learning change during the semester?

Flipped Learning

Flipped learning combines two learning approaches: lecture and active learning. The lecture gives faculty a method to demonstrate expertise to students, passing on valuable knowledge from their experiences. The problem is that the delivery of the lecture makes learning active for the lecturer, not the students. Students need to actively use this newly acquired information, exploring and hypothesizing, to facilitate comprehension and retention (Huba & Freed, 2000). Exploring and hypothesizing can lead to higher levels of learning, which is the goal of flipped learning. The flipped learning approach uses recorded lectures before class for factual information, and active learning during class to promote higher level learning. The use of these two approaches, in this sequence, has made flipped learning an exciting new teaching approach. Before exploring specific flipped learning research, it is helpful to understand the history of lecture and the resistance to move to more active learning teaching strategies.

Lecture

The lecture has been around since medieval times and has remained popular throughout the 20th century. The lecture has remained the dominant form of instruction, largely related to economics, and familiarity to educators, as described in the following two sections.

Economics. The popularity of lecture on college campuses is driven largely by economics. From a monetary, time, and effort standpoint, lecture provides substantial value. Undergraduate enrollment in higher education increased from 10.8 million in 1970 to 17.7 million in 2012 ("Fast Facts," n.d.). Along with increasing enrollments in higher education, state and local appropriations declined from a peak of 60.3 percent in 1975, to 30.4 percent in 2010 (Mortenson, 2012). The demand for resources, coupled with decreased funding, has made lecture the popular choice, based purely on economics. The issue of increasing enrollment and declining appropriations is not likely to improve. Sentiments nationally are that higher education should be affordable and accessible to every U.S. citizen. Some may question the effectiveness of lecture; however, economically, lecture makes sense, and economics is currently driving the conversation in higher education.

Familiarity. There is no nationally aggregated data to confirm lecture is still the most popular form of instruction; however, surveys in economics and math provide a lens that shows the majority of faculty in those respective disciplines favor lecture (Bressoud, 2011; Watts & Schaur, 2011). The lecture showcases faculties' expertise, providing students a way to explore topics on a level that they are not capable of on their own. Stunkel (1999) captures the power and beauty of the lecture: "at its best, a lecture is a critical, structured, skillful, thoughtful

discourse on questions and findings, delivered by a person who knows what he or she is talking about" (p. 424). The lecture provides a way for faculty to demonstrate their expertise, on topics that may be difficult for students, by modeling their thought process.

The use of lecture because of familiarity is not only borne out of preference; it is also out of necessity. Faculty are working long hours not only teaching, but doing research and service as well. The workload requirements of the professoriate make it difficult to spend extensive time researching and instituting new teaching approaches in the classroom; therefore, faculty continue teaching using a method such as lecture, that is familiar to them; an approach they were likely on the receiving end of as a student, and now are delivering themselves (Ziker et al., 2014).

Active Learning

Although lecture remains popular, another teaching approach known as active learning is showing promise, yet the idea of active learning is not a new concept in higher education, as calls for it can be traced to the 1987 report by the American Association of Higher Education titled *Seven Principles for Good Practice*. The third of seven principles indicates learning should be active, and that the purpose of active learning is to promote interaction between students and faculty. This increased interaction is an essential component of active learning and critical to the overall intellectual and personal development of the students (Chickering & Gamson, 1987).

Prince (2004) provides a broad definition of active learning, "…any instructional method that engages the student in the learning process" (p. 223). In essence, this definition of teaching involves students in the learning process. This broad definition encompasses collaborative learning, cooperative learning, and problem-based learning. Unlike lecture, active learning connects teaching and learning, meaning students are processing the information as they learn the material, not listening passively.

Actively engaging students in the process of learning seems simple; yet, it is fraught with barriers, particularly in how faculty view their role. Education is rich in traditions, and as surveys indicate, lecture is a part of that tradition. Central to this tradition is the faculty perception that their role is at the front of the classroom, delivering "the lecture" to the students (Bonwell & Eison, 1991). The broader movement of active learning minimizes their expertise, effectively moving faculty to the side of the classroom. Change causes discomfort and creates anxiety. The long held tradition of faculty lecturing at the front of the classroom is being challenged, and this change can be a difficult adjustment, yet the evidence suggests higher education needs to change.

A review of the literature indicates the primary proponent of active learning is the Science, Technology, Engineering, and Math (STEM) fields. A meta-analysis conducted by Freeman et al. (2014) shows students in STEM courses who use active learning outperform traditional lecture courses in exam scores, and students were less likely to fail. The average effect size on exam scores was 0.47, falling just below what is considered large. Their findings validate an earlier meta-analysis that compared active learning to lecture and found similar effect sizes (Ruiz-Primo, Briggs, Iverson, Talbot, & Shepard, 2011). A key finding in their study was

failure rates, and how they quantified those rates monetarily. Out of the 29,300 students in their analysis, 33.8% of lecture students failed courses, and 21.8% of active learning students failed courses. These course failures translated to a $3.5 million tuition savings to the students in active learning classes. These findings also demonstrate that students engaged in active learning achieve higher academically, are less likely to fail, and as a consequence, the cost is lower. Given these findings, active learning is an educational approach that faculty, administrators, and stakeholders can align with and support.

Lecture and active learning are well researched approaches supported by empirical evidence (Bligh, 1998; Freeman et al., 2014). Educators need to understand the value of each method as well as its weaknesses; combining lecture and active learning results in flipped learning.

Flipped Learning Research

Jonathan Bergmann and Aaron Sams are considered the pioneers of flipped learning by many (Ash, 2012; K. Fulton, 2012; K. P. Fulton, 2012; Schaffhauser, 2009), yet a search of the literature reveals that the basic principles of flipped learning have been around since the mid-1990s (Meibom, Sadler, Moses, & Litzkow, 1994). Studies in the 1990s evaluated active and passive forms of instruction using web-based lecture software and student perceptions of inverted learning, known as flipped learning today. Jonathan Bergmann and Aaron Sams popularized flipped learning with their successes at Woodland Park High School chronicled in their book: *Flipped Learning: Gateway to Student Engagement.* Educators have been using the idea of flipped classrooms for some time, moving direct instruction outside of class, allowing time in class to be active and student-centered.

While Woodland Park and other schools (e.g., Clintondale High School) experienced success with flipped learning, the body of academic peer-reviewed research is small. Bishop and Verleger (2013) conducted the first and only study to date that provides a synthesis of flipped learning studies. They made three observations from their review: studies focused on student perceptions, generally did not contain control groups, and did not adequately explain the conceptual and theoretical framework used in flipped learning. Therefore, a need existed to provide a theoretical framework for flipped learning and to determine empirically if students achieve higher academically. A thorough review of flipped learning was conducted to determine what has been studied, the methodology used in the studies, and the findings. The investigation uncovered two categories: student perceptions and academic achievement.

Student Perceptions. Students perceptions of the curriculum and teaching approaches may have a significant impact on their academic performance and intellectual development, and positive perceptions of flipped learning are essential to ensure successful student learning outcomes along with its continued growth (Ferreira & Santoso, 2008). Overall, the majority of studies found students preferred the flipped learning format, compared to lecture. Students' positive comments were: (1) they liked working with peers, (2) felt they learned more and were better prepared for practice, and (3) felt more self-directed when the class was over. Students disliked that: (1) the flipped class required more work than traditional lecture, (2) that class was a little crazy at times, and (3) some felt they were not being taught the material (Day & Foley,

2006; Franciszkowicz, 2009; Garver & Roberts, 2013; Gaughan, 2014; McLaughlin et al., 2014; Jennifer Moffett & Mill, 2014; Toto & Nguyen, 2009).

A small number of studies measured students' perceptions longitudinally; they found that students resisted the flipped format early in the semester, yet their views changed positively as the semester progressed. Overall, the students liked the recorded lectures, yet their perceptions of how they should be utilized changed as the semester progressed. Initially, students tried to use the videos to study; however, as the semester progressed, they found that the videos were better for introducing new material and did not work well for studying (Day & Foley, 2006; Mason, Shuman, & Cook, 2013).

Student preferences, not just learning outcomes, plays a role in how teaching approaches are viewed by students. Overall, students have a positive perception of flipped learning, yet some findings show faculty need to improve the course experience by better explaining what flipped learning is, and showing the students how to utilize the recorded lectures. Student perceptions of the teaching approach and course structure are an important consideration, when determining how to teach specific content. A negative view of the approach and structure of the course can impact student learning and development.

Student Achievement. The literature review on flipped learning revealed a limited number of studies that used some form of a control group. In some studies, researchers used control groups from different semesters and failed to control for aptitude (Grade Point Average). The quality and a small number of studies make it difficult to claim empirically that flipped learning leads to higher student achievement. Overall, findings showed that students had higher academic achievement in flipped learning classrooms (Day & Foley, 2006; Meibom et al., 1994; Jennifer Moffett & Mill, 2014).

Day and Foley (2006) found students in the flipped section had significantly higher grades than the lecture section. Students in the flipped section had statistically significant higher means scores on homework assignments, class projects, exams, and the final course grade. The results of this well-designed study show flipped learning can increase students' achievement, yet one study makes it difficult to claim flipped learning is a success.

A significant portion of the flipped learning literature consists of anecdotal claims and stories of how educators implemented the flipped learning approach into their classes. To move forward, educators need to build a body of scientific research that demonstrates students perform better academically in flipped classrooms, compared to traditional approaches.

Flipped learning is an exciting new teaching approach; however, there is a lack of empirical evidence affirming educators' anecdotal claims of increased student achievement and higher level learning. As flipped learning research moves forward, it will be vital to use control groups and provide more detailed methodology that goes beyond anecdotal claims of success, and move toward empirical evidence. This study aims to add to this body of research, and to build on past findings.

Methodology

This study utilized a convenience sample of students enrolled in a sophomore level human factors aviation course. The research design for this project was guided by the Day and Foley (2006) study and the Tiwari, Sai, So, and Yuen (2006) study. Day and Foley (2006) were the first to employ a longitudinal design in flipped learning research (Bishop & Verleger, 2013).

To provide a baseline for the study, a lecture section control group was utilized for the study. A basic pretest/posttest over the course of a 16-week college semester was used to determine if changes in student disposition were significant after exposure to the flipped learning treatment.

A total of 109 students participated across 16 weeks: 56 students in the flipped section and 53 in the lecture section. The students in the flipped learning section met once each week on Friday from 9-10:50 AM. The lecture section met two times per week on Mondays and Wednesdays from 1-1:50 PM.

To measure students' perceptions the Course Evaluation Survey (CES) was utilized. Some revision to the wording on CES were made to address cultural differences. It should be noted that the CES has been modified and used in various studies and settings, and is also referred to as the Course Evaluation Questionnaire (CEQ).

Course Evaluation Survey. The CES was created by Paul Ramsden to explore student perceptions of the quality of courses they had completed (Ramsden, 1991; Ramsden & Entwistle, 1981). Five constructs are "intermixed" within 24, five-point, Likert-type questions ranging from "strongly disagree" to "strongly agree." The five constructs examined by the CES are: teaching, goals and standards, assessment, workload, and skills. The final question on the CES, which is not part of a construct, asks a student to rate overall course satisfaction. The CES has been extensively used in higher education, in that over 50,000 university graduates have been administered the instrument (Ainley & Long, 1994).

Validity and Reliability of Instruments. An investigation of the literature showed the CES were valid and reliable instruments. A study conducted by Broomfield and Bligh (1998) validated the use of the CES by "…demonstrating satisfactory construct validity and reliability for the inventory" (p. 367). A recent study on flipped learning by Moffett and Mill (2014) used the CES (called the CEQ in their study) to measure student perception and reported a Cronbach Alpha of .83, indicating the instrument is consistent and reliable. A basic reliability analysis was conducted on the CES for this study and can be seen in Table 1.

Table 1

CES Reliability Analysis

Scale	*N*	Possible Range	Actual Range	*M*(SD)	Cronbach's Alpha
Pre-Test					
Teaching	76	1-5	2-4.83	3.84(.50)	.79
Goals	79	1-5	2.25-4	3.61(.34)	.74
Assessment	76	1-5	1.33-4.67	2.88(.81)	.82
Workload	76	1-5	1-4	2.40(.60)	.70
Skills	76	1-5	2-5	3.52(.59)	.86
Post-Test					
Teaching	79	1-5	1.50-5	4.13(.60)	.85
Goals	79	1-5	2.25-4	3.61(.34)	.73
Assessment	79	1-5	1.33-5	2.73(.72)	.53
Workload	79	1-5	1-3.75	2.30(.57)	.68
Skills	79	1-5	2-5	3.68(.65)	.86

Results

Research Question 1: Do students in a flipped learning course perform better academically than students in a lecture course?

Block Exam Analysis

Before analysis of the block exams and final exam started, the students GPA was tested to determine if differences existed between the groups. In addition, a brief explanation of how the exam was designed is provided, followed by the statistical results for exam 1, exam 2, and the final exam. A critical alpha value of .05 ($\alpha = .05$) was used to determine statistical significance.

GPA. To determine if GPA differences exited between the lecture and flipped groups, an independent samples *t*-test was conducted prior to analyzing the test scores statistically. Table 2 shows the results were not significant, indicating that the groups have similar GPAs. Regardless, GPA will be used as a covariate on all analysis in this section.

Table 2

Results of GPA Analysis

	N	*M*	SD	*M*diff	*t*	*df*	*p*
GPA				.03	-.161	79	.872
Lecture	38	3.32	.69				
Flipped	43	3.35	.86				

Exam Design. The exams used in this course were designed to measure student performance in four areas: their overall score, their knowledge level, their comprehension level,

and their application level. Overall score is a traditional way to measure academic performance; however, to examine performance at a more granular level, the tests are designed based on the first three levels of learning in Bloom's Taxonomy. Guidance on constructing test questions based on Bloom Taxonomy was provided by a paper published by Allen and Tanner (2002). Due to this course being a 200-level university course, levels above application (analysis, synthesis, and evaluation) were not measured.

Block 1 Exam. A multivariate analysis of covariance (MANCOVA), that controlled for GPA, was used to determine if mean differences existed between the lecture and flipped sections on the Block 1 Exam. No statistically significant differences were found in the students academic performance based on a participants' grouping (lecture or flipped), F (4, 75) = 2.48, $p > .05$, partial $\eta^2 = .158$. Results are presented in Table 3.

Table 3

Block 1 Exam Results

Block 1 Exam	*N*	*M*	SD	*M*diff
Overall Score				4.68
Lecture	38	86.21	7.17	
Flipped	43	81.53	9.41	
Knowledge Score				.61
Lecture	38	12.03	1.15	
Flipped	43	11.42	1.65	
Comprehension				.35
Lecture	38	10.84	1.42	
Flipped	43	10.49	1.87	
Application				.39
Lecture	38	11.47	1.18	
Flipped	43	10.58	1.84	

Block 2 Exam. A multivariate analysis of covariance (MANCOVA), which controlled for GPA, was used to determine if mean differences existed between the lecture and flipped sections on the Block 2 Exam. No statistically significant difference was found in academic performance on the Block 2 Exam based on a participants grouping (lecture or flipped), F (4, 75) = .632, $p > .05$, partial $\eta^2 = .033$. Results are presented in Table 4.

Table 4

Block 2 Exam Results

Block 2 Exam	*N*	*M*	SD	*M*diff
Overall Score				1.27
Lecture	38	82.03	8.096	
Flipped	43	80.76	11.163	
Knowledge Score				.20
Lecture	38	11.87	1.19	
Flipped	43	11.67	1.39	
Comprehension				.39
Lecture	38	10.92	1.76	
Flipped	43	10.53	2.06	
Application				-.15
Lecture	38	9.92	1.38	
Flipped	43	10.07	1.84	

*Critical $\alpha = .05$

Final Exam. A multivariate analysis of covariance (MANCOVA), that controlled for GPA, was used to determine if mean differences existed between the lecture and flipped sections on the Final Exam. No statistically significant difference was found in academic performance on the Final Exam based on a participant's grouping (lecture or flipped), F (4, 75) = .632, $p > .05$, partial $\eta^2 = .033$. Results are presented in Table 5.

Table 5

Final Exam Results

Final Exam	*N*	*M*	SD	*M*diff
Overall Score				1.67
Lecture	38	90.00	6.51	
Flipped	43	88.33	8.31	
Knowledge Score				-.16
Lecture	38	19.00	1.34	
Flipped	43	19.16	1.48	
Comprehension				.92
Lecture	38	13.18	1.43	
Flipped	43	12.26	1.92	
Application				.15
Lecture	38	12.82	1.59	
Flipped	43	12.67	1.87	

Research Question 2: Do students perceptions of flipped learning change during the semester?

To determine if the students perceptions changed during the semester, two statistical tests were used, an independent samples *t*-test, and a paired-samples *t*-test, to analyze the results of the CES survey given in week 4 (pre-test), and again in week 15 (post-test). The paired samples *t*-test was used to investigate if a student's perceptions changed within their group (e.g, lecture pre-test to lecture post-test), and the independent samples t-test was used to determine if a significant difference existed between the lecture and flipped groups (lecture versus flipped).

The results of the CES are broken down by their summed scales which are named: teaching, goals, assessment, workload, and skills. In addition to the scales, one question was asked regarding how satisfied a participant was with the course. The alpha level for all statistical tests was set at .05, and effect size was calculated for the results which rejected the null hypothesis (significant). Prior to running the paired sample *t*-tests, the file was split based on the grouping variable, lecture and flipped.

Overall Course Satisfaction

A paired samples *t*-test was conducted to examine if within group differences of the lecture and flipped groups course satisfaction variable. Table 6 shows the mean score comparison from the pre-test to post-test for both groups. Satisfaction scores in the lecture section increased significantly $t(36) = -2.707$, $p = .010$, indicating students were more satisfied with the lecture course at the end of the course when compared to the beginning of the course. A small to medium effect was calculatated ($d = .443$). Scores in the flipped section were not significant, however, the mean increased slightly from the pre-test to post-test.

Table 6

Overall Course Satisfaction Variable

Variable: Course Satisfaction	*N*	*M*	SD	*M*diff	*t*	*df*	*p*	*d*
Lecture				0.35	-2.707	36	.010	-.443
Pre-Test	37	3.95	.62					
Post-Test	37	4.30	.62					
Flipped				.11	-.644	37	.524	
Pre-Test	38	3.92	.85					
Post-Test	38	4.03	.94					

CES Constructs Analysis. A paired samples *t*-test was conducted to determine if mean differences existed within the teaching variable. The results, summarized in Table 7, show that lecture and flipped sections teaching scale was significant. The means in both groups increased from the pre-test the post-test, indicating the students felt that the teaching had improved at the end of the semester. Evaluation of effect size on the teaching variable shows the flipped section had a small mean change ($d = .35$) while the lecture section had a medium change ($d = .67$).

Table 7

Teaching Variable

Variable: Teaching	*N*	*M*	SD	*M*diff	*t*	*df*	*p*	*d*
Lecture				.36	-4.019	36	.000	-.667
Pre-Test	37	3.79	.36					
Post-Test	37	4.14	.51					
Flipped				.23	-2.071	37	.045	-.347
Pre-Test	38	3.90	.61					
Post-Test	38	4.13	.69					

A paired samples *t*-test was run to examine the within group mean differences of the lecture and flipped groups for the goals and standards variable. The results, summarized in Table 8, show a significant difference in the lecture and flipped sections. The overall mean decreased from pre-test to post-test in both groups, which indicates that the students felt the goals and standards were less clear as the semester progressed. Effect size evaluation indicates the mean change for lecture was medium for both lecture and flipped sections.

Table 8.

Goals and Standards Variable

Variable: Goals and Standards	*N*	*M*	SD	*M*diff	*t*	*df*	*p*	*d*
Lecture				-.24*	3.121	36	.004	.585
Pre-Test	37	3.87	.50					
Post-Test	37	3.63	.21					
Flipped				-.45*	4.342	37	.000	.720
Pre-Test	38	4.07	.60					
Post-Test	38	3.61	.42					

*A negative number indicates a decrease from the pre-test to post-test score

A paired samples *t*-test was conducted to examine the within group differences of the lecture and flipped groups assessment scale. The results, summarized in Table 9, show no significant differences from pre-test to post-test for the lecture or flipped sections.

Table 9

Assessment Variable

Variable: Assessment	*N*	*M*	SD	*M*diff	*t*	*df*	*p*	*d*
Lecture				-.21*	1.419	36	.164	
Pre-Test	37	2.99	.82					
Post-Test	37	2.78	.83					
Flipped				-.13*	0.965	37	.341	
Pre-Test	38	2.77	.81					
Post-Test	38	2.64	.59					

*A negative number indicates a decrease from the pre-test to post-test score

A paired samples *t*-test was conducted to examine the within group mean differences of the workload variable. The results, summarized in Table 10, show no significant differences from pretest to posttest for the lecture or flipped sections.

Table 10

Workload Variable

Variable: Workload	*N*	*M*	SD	*M*diff	*t*	*df*	*p*	*d*
Lecture				-.16*	1.508	36	.140	
Pre-Test	37	2.51	.54					
Post-Test	37	2.35	.56					
Flipped				-.08*	0.673	37	.505	
Pre-Test	38	2.30	.64					
Post-Test	38	2.22	.60					

*A negative number indicates a decrease from the pre-test to post-test score

A paired samples *t*-test was run to examine the within group differences of the lecture and flipped groups skills variable. The results, summarized in Table 11, show a significant difference in the lecture group, with the overall mean increasing from pre-test to post-test, indicating that the students perceived their skills in problem solving, planning, and working within a group, improved as the semester progressed. Effect size calculations show a small mean change (d = .37).

Table 11.

Skills Variable

Variable: Skills	*N*	*M*	SD	*M*diff	*t*	*df*	*p*	*d*
Lecture				.20	-2.245	36	.031	-.368
Pre-Test	37	3.56	.48					
Post-Test	37	3.76	.53					
Flipped				.07	-.750	37	.458	
Pre-Test	38	3.50	.68					
Post-Test	38	3.57	.73					

Group Differences Results for the CES

CES Results. To begin the between groups analysis of lecture versus flipped sections, a delta (Δ) value was calculated for the pre-test to post-test score for the lecture and flipped groups, creating a new variable.

X_1=pretest scores
X_2=posttest scores
D (Δ) =X_2-X_1
(e.g. Lecture X_1 – Lecture X_2 = (Δ) D)

The difference score was then used to determine if between group differences existed between the lecture and flipped section for the CES overall score and five scales.

An independent samples *t*-test was conducted to determine if differences in mean scores on the CES existed between the lecture and flipped groups. Table 12 shows a comparison between the lecture and flipped group for the overall score and five scales. The results show there is not a significant difference between the lecture and flipped groups delta scores for overall course satisfaction, teaching, goals and standards, assessment, workload, and skills.

Table 12.

Group Differences for the Course Evaluation Survey

Variable	*N*	*M*	SD	*M*diff	*t*	*df*	*p*	*d*
Overall Course Satisfaction				.24	-1.175	73	.244	
Lecture	37	.35	.79					
Flipped	38	.11	1.01					
Teaching				.14	-.95	73	.346	
Lecture	37	.36	.54					
Flipped	38	.22	.67					
Goals and Standards				.22	-1.67	73	.100	
Lecture	37	-.24	.47					
Flipped	38	-.46	.65					
Assessment				.07	.389	73	.698	
Lecture	37	-.20	.87					
Flipped	38	-.13	.81					
Workload				.09	.591	73	.557	
Lecture	37	-.16	.65					
Flipped	38	-.07	.66					
Skills				.14	-1.156	73	.251	
Lecture	37	.20	.55					
Flipped	38	.06	.50					

Student Comments on Flipped Learning

Positive Comments. Students were asked a simple open-ended question on the week 15 CES: what are some good things about the course? Several comments centered on how much the flipped format promoted discussion, increased collaboration, the ability to ask frequent questions, and that they generally were more engaged:

> *I like the set up of the class. Help to keep student engage.*

> *I loved the flipped setting. It was always great to be able to collaborate in groups and share ideas. It was also nice to be able to clear up misunderstanding by talking about what each of us had learned. Additionally the "ask a question" lecture style was very helpful to me since it answered my questions and sometimes questions I didn't even know I had.*

> *Overall, I enjoyed the course. To be honest, staying motivated to actually watch the videos during breaks was difficult, but I think the lecture videos was a really good idea. This way, we could have discussions about the material in class and work on things we didn't understand. I really enjoyed the flipped course method!*

I thought the class periods were very informative, I liked that students got direct feedback to questions the didn't understand from the lectures. I also thought that working through the problems and situations as a group at a table was beneficial to my learning. We got to work in groups which has helped me get a better understanding of the information when I don't understand the teacher.

The overall materiel was very interesting. I liked being able to review specific case studies to be able to match it to the information that we were learning. I also liked that everything was available online. If I missed class for some reason, I didn't feel like I missed a bunch because I could view the lesson online.

The emphasis on group work and discussion, the new classroom format. / The WSQ, although it seemed like busy work at times really does help understanding of the material.

It was very easy to ask questions. Any time i needed help I could just ask the teacher because of how the discussion orientated the class was.

I think that this course was a great change. i think that the lecturing is forcing students to memorize and forget when we should be applying these things. i think that this course was very good at showing the students the power that they have in a situation. assertive statements are a huge thing that i think to many do not have a good grasp of.

The flipped classroom environment made us more engaged and made us apply our short learned knowledge as opposed to sitting through a lecture.

I really liked the flipped classroom setting. I absolutely hate lectures and would rather be hands on learning. I think the video lectures outside of class were nice because I could watch them on my own time.

I really enjoyed the open atmosphere in the class and the fact that you could ask anything. I enjoyed doing the homework outside of class and then discussing it in class, I feel like that really had a positive impact on retention.

The teaching method in the way that the lectures would be entirely online and the whole class as one would come to discuss the lectures in class. The muddy points helped make misunderstandings clear and really helped in the note taking process.

I liked the group aspect of interacting with the content of the course and not just sitting in front of a lecture. The two hours of class definitely seemed to go by relatively quickly.

The conversational feel of the lectures both online and in class are great for developing ideas and comprehending things discussed. The active recall of information using the whiteboards as a group are effective in assisting the processing of information learned. / The WSQ sheets help to extract the key information and perspective from the video lectures.

Negative Comments. On the week fifteen CES survey students were asked a simple open ended question: what are some things you dislike about the course? While students in general had positive feedback (based on CES and qualitative responses), several identified and spoke to some areas of concern:

Several negative comments spoke to the frequency (interval) of the class and how it may have affected their retention:

> *I would prefer to have one lesson for each lecture rather than long lecture with two lessons.*
>
> *Only once a week will be too easy for students lose track and memory about what we learned last week. If can change this class to half semester and maybe 2 days a week it will be better for student.*
>
> *That it is once a week on Fridays, i feel that i missed some important things due to friday holidays.*
>
> *It is only once a week, by the time I get to the next class a week later, I have already forgotten some of the things from the previous week.*
>
> *The uncertainty of my grade. Only having it once per week makes it harder to retain the information.*

The students made several comments regarding the difficulties they faced with the size and layout of the room:

> *The room was OK. I really had to move around to face the teacher.*
>
> *The size of the room. I feel the same class structure on a smaller scale would work better for myself. / The videos are very in depth but I find them harder to pay attention to than a traditional lecture.*
>
> *I felt like the class was too separated. The room was really big, and the tables felt really spaced out. Also, When ever we had to talk to the class, we had to spend a lot of time trying to pass around the microphone, which took up class time. Last thing was that because we were all sitting in different directions (unlike a lecture hall where you maintain constant eye contact with the professor), I didn't feel as focused as I wouldve like to. I sometimes found myself going online when there was a lot of downtime (which also falls back on the trouble with the microphones), instead of focusing on the discussions. I think just over all, the class just needs to be streamlined so that there is less down time.*

A few participants commented that they did not like the flipped format, mainly because they preferred the lecture format, or felt it was difficult to prepare for exams:

> *Honestly, I wasn't a huge fan of the flipped classroom style. I think because I am so used to lecture style classes, I have learned to learn in a specific way from those courses, and this course changed that. I was able to do as well as I wanted to(hopefully) however, so I think the class style works.*

> *I did not like that there was not much help when it came to test preparedness. All we were given was packets that we were supposed to gain all of our knowledge from. There was nothing available to actually practice and apply the knowledge that we had. Having quizzes was helpful, but did not really help apply what we learned. It just tested our knowledge.*

Summary

Two research questions were addressed, which looked at student perceptions and academic performance. The results addressed the within group differences (e.g, lecture pre-test to lecture post-test), and the between group differences (e.g, lecture versus flipped). Provided is a detailed discussion of the results, implications for practice, and future research.

Research Question 1: Do students in a flipped learning course perform better academically than students in a lecture course?

This part of the study was designed to test if students performed better academically in the flipped group versus the lecture group. No statistical significance was found between groups on their overall scores, their knowledge level, their comprehension level, or their application level.

Findings. Although the results were not significant, there may be two explanations for why the flipped group failed to outperform the lecture group academically: intervals and the students lack experience with the flipped format. The concept of spaced learning intervals is important to understanding the results of this study, specifically on this question regarding academics. Time and frequency of the class meetings, which is dictated by a multitude of factors, can significantly impact learning. This class is a two credit course, which means the class usually meets two times per week for one hour; however, due to scheduling issues in the SCALE-UP (Student-Centered Active Learning Environment) classroom, the flipped section needed to be scheduled one time per week for two hours. On the surface, this scheduling difference seems like a minor detail. Nonetheless, the researcher believes that this variable had a significant impact on the academic results of this study.

Discussion. Why does the learning interval matter so much? The lessons in the flipped classroom, within each block of learning, are designed to build on each other, meaning the students need to master the current knowledge and retain it to be successful for the next lesson because they will be actively using the material in class. At one point in the semester, due to the holiday schedule, the class did not meet for three weeks; however, the time allotted in class also

prevented a significant amount of review in-class. Qualitative comments from students in the flipped class regarding this issue follow:

> *only once a week will be too easy for students lose track and memory about what we learned last week. If can change this class to half semester and maybe 2 days a week it will be better for student.*
>
> *it is only once a week, by the time I get to the next class a week later, I have already forgotten some of the things from the previous week.*
>
> *The uncertainty of my grade. Only having it once per week makes it harder to retain the information.*

The flipped learning model requires the students to be more self-directed, meaning the burden to motivate themselves to study and review the course material falls primarily in their hands. Having to be more self-directed, coupled with a class that meets only once a week, required internal motivation skills some students may not have had, as this comment suggests:

> *It is harder to motivate myself outside of class, so while watching the video lectures i would often get side tracked and wouldnt fully understand what was being discused. I would also like to see the slide in the video lectures available for use so we are able to go back and look at deffinitions and theroies with out having to rewatch the videos.*

The qualitative comments showed that students struggled with the class only meeting once per week, and that they found staying motivated in the flipped format difficult. A large body of research, summarized in Thalheimer (2006) *Spacing Learning Events Over Time: What the Research Says*, covers spaced learning in detail; and while outside the scope of this study, this research should be applied to the flipped learning model.

Another issue was that 87% of students were experiencing the flipped learning teaching design for the first time, which may have caused frustration and anxiety. The literature speaks to some frustration students feel with the flipped classroom (Day & Foley, 2006), along with the qualitative comments of this study. Student comfort level in the classroom is essential to their success, and being in a large active learning space for the first time may have impacted their learning. The students made several negative comments regarding the class; following is an example:

> *I felt like the class was too separated. The room was really big, and the tables felt really spaced out. Also, When ever we had to talk to the class, we had to spend a lot of time trying to pass around the microphone, which took up class time. Last thing was that because we were all sitting in different directions (unlike a lecture hall where you maintain constant eye contact with the professor), I didn't feel as focused as I wouldve like to. I sometimes found myself going online when there was a lot of downtime (which also falls back on the trouble with the microphones), instead of focusing on the discussions. I think just over all, the class just needs to be streamlined so that there is less down time.*

Acclimating to a new space can take away from the educational experience. Conducting the research, this phenomenon was observed first hand in the classroom. The students had a hard time tracking me if I was speaking, and they genuinely disliked that the size of the classroom required the use of microphones to ensure others could hear them when they were speaking.

Research Question 2: Do students' perceptions of flipped learning change during the semester?

This part of the study was designed to test within-group differences, and between-group differences in students' perceptions as the semester progressed. The results of the CES showed that the students in the lecture section had higher overall course satisfaction and a significant increase in perceived skills over the semester, and both groups rated teaching and goals significantly higher on the post-test. No significance was found on the between groups analysis to substantiate the within groups findings.

Findings. Overall course satisfaction increased significantly from pre-test (M=3.95) to post-test (M=4.14) in the lecture group, indicating that students enjoyed the class more as the semester progressed. Also, scoring on the teaching scale significantly increased in the lecture group from pre-test (M=3.79) to post-test (M=4.14). The combination of these two significant results may indicate that the faculty member teaching the course had the largest impact on the students' overall course satisfaction in the lecture group; the literature validates this finding and claim, as a high score on the teaching scale has the highest correlation with overall course satisfaction (Ainley & Long, 1994). Faculty in a lecture setting are at the center of the classroom, making it logical that they will have a significant impact on course satisfaction. On the other hand, faculty in a flipped classroom are not the focal point, which may account for a slightly lower satisfaction score.

Discussion. While finding that the students had a higher overall satisfaction in the lecture group, and not in the flipped group, may be somewhat surprising; a possible explanation will be proposed. The lecture groups participants had a higher level of satisfaction overall and in the teaching variable also. In the flipped learning environment, the faculty member is, as Burgman (2006) states "a guide by the side rather than a sage on the stage" (n.p). When compared to lecture, this means that the faculty role is limited, being the source of less satisfaction. Another issue that may have affected the lower satisfaction scores in the flipped section is that only 5 of the 43 participants indicated they had previously taken a flipped course. A small number of studies that measured students' perceptions longitudinally (Day & Foley, 2006; Mason et al., 2013) found that there was some resistance to the flipped format, specifically at the start of the semester. Students who are thrust into a flipped style active learning classroom, where the instructor takes a smaller role, may feel some uneasiness, which may decrease over the semester, nonetheless, it may not be enough time for a complete adjustment. It is worth noting that the pre-test score for the lecture section and the flipped section were high M=3.95 and M=3.92 respectively, which indicates that the students generally "agreed" with the statement "Overall, I was satisfied with the quality of this course."

Conclusions. Faculty will continue to have a significant impact on the students' course satisfaction and academic performance regardless of the teaching approach. As higher education moves to more active learning techniques, faculty and administrators would be wise to remember that students who are new to the course delivery technique (as the majority were in this research) may experience more dissatisfaction with the course.

Future research would benefit by focusing more on the students' perceptions of flipped learning prior to starting the academic material. In addition, researchers should carefully consider intervals when planning their experiments. Active learning will continue to be a growing part of delivering higher education, faculty would be benefit from a larger body of scientific research on flipped learning.

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