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The Perceived Effects of Flipped Teaching on Knowledge Acquisition

Galen Newman[1a], Jun-Hyun Kim[a], Ryun Jung Lee[a],
Brandy A. Brown[b], and Sharon Huston[a]
[a]*Texas A&M University, College Station, TX, 77843*
[b]*University of Arizona, Tucson, AZ 85757*

Abstract

Increased demands for technological integration in higher education have resulted in new forms of course instruction. Under a flipped approach, students learn course materials outside the classroom while active learning methods are employed inside. This study focuses on the perceived effects of flipped instruction on knowledge acquisition in undergraduate students using information communication, accessibility, stimulation, interaction, and accumulation as measures. Undergraduate students indicated positive effects of flipped teaching and student's perceived learning improved as time spent using learning management systems increased. While knowledge acquisition tended to increase in most students, technological incompatibilities prevented the flipped approach from being fully accepted.

Keywords: Flipped teaching; higher education; technological pedagogy; blackboard; online instruction.

Increased usage of flipped teaching has inverted not only the classroom, but the entire teaching paradigm. Current pressures for increased enrollment in higher education programs combined with advances in technology have facilitated flipped and blended/hybrid models of teaching to increase active learning (Hobbs, 2013). The difference between the two approaches is that while blended/hybrid teaching seeks to create student learning experiences that flow back and forth between face-to-face and online (or at least technologically supported) situations, flipped teaching exposes students to course material prior to class time (with or without the use of technology), allowing for increased interaction and engagement with the instructor during course time (Ellis Steed, & Applebee, 2006). While the traditional lecture style of teaching remains the norm worldwide (Thomasian, 2011), flipped teaching methods have been widely applied to aid instructors struggling to teach newly developed large classes which cover vast amounts of material in a limited time and cater to a multitude of majors.

While momentum for the approach has gained traction, there is also a debate as to the success of its application. Little research has been conducted on the subject to help settle these debates, specifically research which analyzes the perceived effects that flipped teaching can have on learning (Moravec, Williams, Aguilar-Roca, & O'Dowd, 2010). In

[1] Corresponding author's email: gnewman@arch.tamu.edu

this study, a course covering the History of Landscape Architecture was utilized to assess the perceived effects of flipped teaching on knowledge acquisition. It is assumed that if a student perceives that they are learning more and are benefiting from a certain type of course format, they are likely to have higher levels of engagement and perceive greater value from the course, and that this may lead to better performance and increased rates of persistence and completion. Six of the fifteen week course operationalized flipped instructional delivery. Results from a survey of 183 students in the course were then utilized to analyze the overall perceived effectiveness using five measures – information communication, information accessibility, information stimulation, information interaction, and information accumulation.

Background and Literature Review

Defining flipped teaching

The term, 'flipped teaching' (or 'inverted teaching)' came from the idea of inverting the conventional way instructors impart information (Lasry, Dugdale, & Charles, 2014). The general concept of the model is to move the basic knowledge out of the classroom and then use class time for activities that deepen that knowledge (Love, Hodge, Grandgenett, & Swift, 2014). This model has been used for over two decades in the humanities and has recently become popular in other disciplines, largely due to its promotion in the book *Effective Grading* (Walvoord & Anderson, 2011). Since its inception, the flipped learning model has been used by higher education instructors to reduce the need to communicate easily digestible information and allow both students and faculty to do more active learning, often with the assistance of technology (Hamdan, McKnight, McKnight, & Arfstrom, 2013).

Most research on flipped instruction seeks primarily to define the flipped method rather than explore its effects or perceived effects in the classroom. Lage, Platt, and Treglia (2000) defined it simply as a series of events that have traditionally taken place inside the classroom which now take place outside the classroom, and vice versa. Hamdan et al. (2013) extended this definition by defining it as a way of teaching a group of students with readily available material that can be accessed by students whenever and wherever they want; but concluded that inverted instruction intensifies in-class teaching only when it remains student-centered and based on the needs and abilities of those interacting with the course materials. Bishop and Verleger (2013) identified flipped teaching as an educational technique consisting of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom. This study operationalizes this definition as flipped materials in the course utilized for the study were covered by computer based instruction outside of the classroom utilizing interactive learning modules, cinematic screening, YouTube videos, and access to reading materials, while in class instruction sought to deepen knowledge through module feedback, pre-submitted questions and interactive discussions on materials/questions covered.

The basis for flipped teaching

As far back as 1981, video based lectures in higher education were suggested to help or, in some cases even out-perform in-person lectures (Cohen, Ebeling & Kulik, 1981), yet their adoption in higher education has been sluggish until recently. The implementation of interactive media into lecture based videos has also been shown to help amplify this condition, especially in online platforms (McNeil & Nelson, 1991; Zhang, Zhou, Briggs, & Nunamaker, 2006; Passey, 2011). Nearly 10 years later, researchers such as Eric Mazur (1991) began emphasizing the integration of computers and other technologies into the teaching process. Mazur claimed that, eventually, computers could be tough to help teach and would become an integral and dynamic tool for improving the quality of education.

As Mazur (1991) predicted, the computer has become mandatory in both academia and business. It was not until recently that flipped learning was popularized due primarily to the development of various typologies of online learning and new interactive technological advancements. Khan's (2012) speech at TED Talks amplified this popularity, describing how video could serve as a rapid, widespread means of disseminating information. The speech helped initialize efforts for flipped teaching, suggesting that online material should be efficiently and successfully utilized in mainstream course delivery. In combination with the shift in public opinion, adoption of the model has also been propelled by large scale technological advances, the availability of free or cheaper software, and mounting pressures from increasing tuition costs and free, online course offerings (e.g. massive open online courses, or MOOCs); the combination of these events opened discussions on and catalyzed change in the physical classroom (Bishop & Verleger, 2013).

The flipped model is being adopted rapidly into higher education due, in part, to changes in societal perceptions, the needs and pressures in academic institutions, growths in educational technology options, and a growing emphasis on student engagement. Widespread adoption of the flipped instructional model has been limited for several reasons, including the limited research undertaken to assess the perceptions on student learning that can result from the flipped classroom environment (Love et al., 2014). Miller (2012) indicated that flipped teaching is not a perfect solution to education, but does offer benefits to increasing student engagement. Tucker (2012) expanded this point and posited that more specified strategies were needed to increase student attentiveness and motivation. To achieve this, new interactive tools and multimedia should be incorporated into this novel style of teaching (Sheehy & Bucknall, 2008).

If executed correctly, flipped teaching has shown to be a fairly effective method to organize and disseminate online material to aid in instructional delivery in higher education. The flipped method can help increase the efficacy of in-class learning by affording students the ability to obtain information outside of class. By alleviating the need to force a set of materials into a singular time frame, flipped teaching provides instructors the ability to spend more time with students needing increased assistance while allowing well-performing students more free time (Tucker, 2012). Because flipped courses use mostly online material, in theory, this method can help increase the instructors teaching efficient-

ly leading to higher research and service opportunities. While opportunities to listen to and engage with students increase (Stone, 2012), instructors are also allowed to focus more on their area of expertise (Lasry et al., 2014).

In regards to meeting learning outcomes, the rationale for the flipped model has been supported through the long-standing theoretical basis for (1) effectiveness of active learning (Bransford, Brown, & Cocking, 2000; Grant, 2014), (2) positive effects of improved student-teacher interaction (Toto & Nyugen, 2009), (3) positive effects of real-time feedback (Moravec et al., 2010) and (4) increased student engagement through self-paced learning and more meaningful coursework (Goodwin & Miller, 2013). Much of this research is only indirectly linked and has been conducted mostly in K-12 classrooms, but has shown to have strong correlations with positive learning effects (Goodwin & Miller, 2013). A few isolated articles have reported significant learning gains using this model (Brame, 2014), but there is a general lack of specific evidence on student perceptions of the effects of the flipped approach (Bishop & Verleger, 2013; Herreid & Schiller, 2013).

Perceptions of flipped learning

The growing number of instructors and researchers have presented only a small body of work investigating the effectiveness of flipped teaching. Studies in higher education examining perception seem to be relatively consistent in their conclusions that overall opinions on the approach tends to be positive with relatively small ratios of students strongly disliking the method (Bishop & Verleger, 2013). Students tend to watch most assigned lecture videos and came to class better prepared than those asked to complete typical pre-class textbook reading assignments (deGrazia, Falconer, Nicodemus, & Medlin, 2012). Other studies reinforce this notion, suggesting that many higher education students do not typically complete assigned readings (Sappington, Kinsey & Munsayac, 2002). Requiring pre-class quizzes or some form of formative questioning on the materials covered was also shown as a common method for increasing learning in most flipped approaches.

Student perceptions of flipped learning can sometimes be a bit conflicting. Students, just like anyone else, can sometimes be resistant to change, regardless of improved outcomes which can result in lower perceptions for newer teaching models (Martin, 2012). One study found, while there was a preference for in-person lectures over video lectures, there was also a contradicting preference for the class interaction afforded by flipping the course (Toto & Nyugen, 2009). This paradox has been found to be somewhat alleviated if shorter or more organized, less-lengthy videos are utilized as out of class materials (Zappe, Leicht, Messner, Litzinger, & Lee, 2009). The use of video lectures coupled with worksheets or some form of formative/summative technique was also shown by Moravec et al., (2010) to increase overall performance in the class by up to 21%. This technique has also been shown to increase scores on individual homework assignments, projects and tests (Day & Foley, 2006).

Despite these benefits, flipped teaching can also present some drawbacks. The first, and primary, issue is the ability to access course information. Technical glitches may deter students from concentrating on learning materials and/or working on assignments (Saban,

2013). Also, equity can be a concern. Underserved persons without internet access may have limited or no capability to access materials away from campus (Driscoll, 2012). Thirdly, stimulation of students outside of class using online materials can be difficult. Although online materials have been shown to increase enthusiasm in some cases (because they are different than some traditional drab lecture techniques), students can have difficulty being self-motivated from studying alone at home without the professor present and can become easily dissatisfied (Tune, Sturek, & Basile, 2013). The utility of different types of online materials can help students feel more dynamic when undertaking their assignments but this requires that professors and students become familiar with new software (Mayer, 2003). Some case study results support the idea that flipped materials assist students in controlling their own pace when studying (McLaughlin et al., 2014) but overall results tend to vary depending on class size (Stone, 2012).

Much research on flipped teaching has shown that an approach incorporating a multitude of instructional delivery types allows the flipped model to cater to several learning styles while increasing interaction (Fredericks et al., 2013). Google sites such as survey tools have also been used to create interactive lectures with relative ease in regards to both instructors use-ability and student operationalization (Saban, 2013). Lasry et al.'s (2014) approach, known as "Just in Time Teaching (Flip-JiTT)", shows great promise as a flipped framework and includes assigned textbook readings coupled with computer simulations and online video tutorials as a means of reinforcing lecture material through repetition. Bergmann and Sams (2008) made video casts, or vodcasts, of their lectures and saw a letter grade improvement in many of their high school students. Further, when comparing scores with state exams the average scores of students being taught with the flipped method in high school were nearly identical, meaning that the flipped approach produces at least comparable test scores as the traditional method. Other courses have used features such as web-based modules containing lecture materials, videos, and formative questioning as a means of increasing interactivity through flipped instructional delivery.

Flipped teaching and knowledge acquisition

The goal of any course (flipped or non-flipped) is to improve teaching and learning environments while delivering the instructors' knowledge efficiently to students. This can be accomplished through a variety of student-centered, active learning strategies. The basic premise behind instructional inversion is that students formulate or acquire knowledge through participation with course material while learning self-motivational skills through the opportunity of self-paced learning and information review (Hamdan et al., 2013). Although the effectiveness of the flipped method has been debated, studies using flipped classrooms have shown significant increases in performance based on summative assessment compared to standard lecture-based courses (Bishop & Verleger, 2013; Herreid & Schiller, 2013). These results have typically been based only on comparisons between scores in summative assessment techniques such as quizzes or exams, making it difficult to determine what specifically causes increases in performance (Tune et al., 2013)

Even in research studies showing no significant grade differences between traditional-lecture-based and flipped courses, students still perceived they had acquired more knowledge through the inverted class style of teaching (Findlay-Thompson & Mombourquette, 2014). In flipped courses, students learn lecture materials outside the class and are able to relearn difficult materials in-class, which makes the knowledge delivery process perceptively more complex. Simultaneously, students are influenced by various factors that contribute to better understanding of the curriculum. For instance, the increased interaction with instructors may lead students to a better comprehension of class materials or the increased convenience of access to course materials may increase student motivation. For these reasons, the positive effects of flipped teaching cannot be determined by only examining summative assessment scores. Research must also begin to evaluate the specific effects of flipped instruction on the acquisition of knowledge in order to glean more thorough understanding of its influence. Perhaps the first step in addressing this issue, is to better understand the perceived effects of flipped teaching by students.

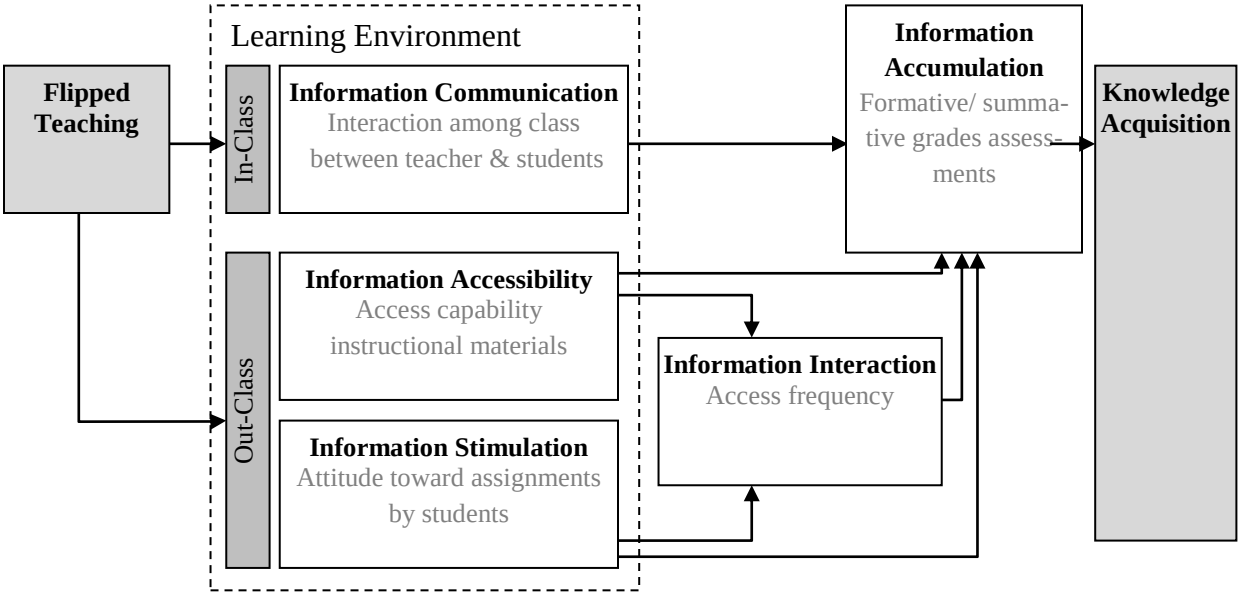
Methodology

Research objectives

This study focuses on assessing the perceived effects of flipped instruction on knowledge acquisition. The objective is to determine if the flipped model can be used as a successful approach for pedagogical delivery in undergraduate teaching based on student perception and performance. Marzano, Pickering, & McTighe (1993) identify information communication, information accessibility, information stimulation, information interaction, and information accumulation as important facets to knowledge acquisition, a key dimension of their five dimensions of learning. On this basis, our study utilizes these facets as measures to assess the perceived effects of flipped teaching on knowledge acquisition (see Figure 1).

Information communication examines inter-student and student-professor contact and exchange of ideas. The out of class features of flipped teaching are highly debated due to the various material used for classes and students' two-sided attitudes on out-class lectures. The quality and ability to access the out of class materials (mostly online materials) is assessed according to the information's accessibility. If the information is highly accessible, the information interaction (as well as the in-class communication) should also increase. As communication, accessibility, and interaction increase, information stimulation is assumed to intensify. Since flipped teaching focuses on the interaction between students and the professor in the classroom in an effort to lead to better perceived information communication, utilizing the flipped model should lead to higher perceived information accumulation, or increases in knowledge, by students. It is assumed that if each variable is positively impacted, then overall perceived effects on knowledge acquisition, or long term procurement of information, will increase.

Figure 1. Conceptual Model of Measures Utilized to assess the effects of Flipped Teaching on Knowledge Acquisition.



Course context

Recent pedagogical research in undergraduate design teaching has concentrated primarily on approaches to studio based instruction, examining elements such as service learning (Doble & King, 2011), interdisciplinarity (Kondolf, Mozingo, Kullmann, McBride, & Anderson, 2013) and participatory based approaches (Hester, 2012). Simultaneously, the paradigm shift from an emphasis in STEM (Science, Technology, Engineering, and Mathematics) based education to STEAM (Science, Technology, Engineering, Arts and Mathematics) education has placed importance on creativity alongside math and science in higher education (Park & Ko, 2012; Kim & Park, 2012). A course with 183 students enrolled covering the History of Landscape Architecture was utilized to carry out this study. The course is a general introduction to the history of human settlement and landscape design/planning, from prehistory to the nineteenth century, primarily outside of North America. Global examples of renowned landscapes are introduced in class and discussed in reference to their historical development and discussed in regards to their particular cultural and philosophical contexts. The methods employed through course inversion were exercises involving mixed-media and interactive online learning modules with built-in formative questioning.

Six of the fifteen week course operationalized flipped instructional delivery. During flipped sections, students were assigned to (1) individually complete online lecture modules, (2) answer the embedded questions about the materials covered and (3) prepare two discussion questions prior to each class for in-class dialogue, clarification, and to facilitate interaction for formative assessment purposes. Of the twelve topics covered in the course, every two topics were summative in-class quizzes were distributed (six total) and

every three topics summative online tests were distributed (four total). The lecture modules were developed as interactive instructional delivery vehicles with formative assessment questions built into them to be completed outside of class. A point value for correct answers were given and grades calculated based on performance for each module. A survey was conducted at the end of the semester in an attempt to gauge the perceived effectiveness of the flipped teaching method.

All interactive modules were developed as SCORM (Shared Content Object Repository Model) learning objects. SCORM objects record the history of a student's interactions with the object, and are capable of automatically grading objective questions (such as multiple choice, drag and drop or true-false) and report resulting grades to learning management systems (LMS). The multimedia designers used Articulate Storyline to develop the modules, each which contained downloadable key terms, audio, images, video, assessment questions, and closed captioning. The university the course was taught at recently adopted Blackboard as its LMS, so all modules were uploaded to a Blackboard classroom and all grades were stored in the Blackboard Grade Center through the eCampus platform. The eCampus platform is an online learning management system for storing and organizing course materials. It houses Blackboard and other software all in one arena and allows for student interaction with course materials. Other analytic data, including student responses for formative module questions and the number of times students accessed the modules, were also recorded in eCampus. A combination of lecture modules, PDFs of the lectures, online cinematic screenings, YouTube videos, and one-chapter readings per lecture module were all assembled as accessible information through eCampus. Student performance in class was analyzed through the combination of tests, quizzes, discussion forum/question postings and module scores. Quizzes were taken in class using iClickers to compare students' performance on topics covered while four summative tests were taken out of class online at designated times.

Surveyance and analysis

The survey had a 100% response rate and consisted of 28 questions. Self-selection bias was examined in the survey through asking students if they had known about eCampus use in the course before it began. Over 84.2% were not aware of the high utility of eCampus when they registered for the class. Of the 183 students registered in the course, there were close proportions of each gender (female: 41.0%, male: 59.0%). Students were evenly distributed in terms of their background with the course harboring 32 different majors (see Table 1). Over 60% of the students had not used eCampus prior to the course (due to the University's recent adoption of the media), with 45.9% of students responding they had previous experience with online courses.

Each survey was taken individually, using Qualtrics online survey software. Students were assured their responses were recorded anonymously. Among the responses, 81.4% of students answered they had used the modules according to the specific instructions provided prior to class by the instructor, increasing the reliability of results.

The survey instrument was categorized to gather information on students' (1) background, (2) perceived learning experience in the course, (3) preferences for course materials and assessment tools utilized in the course, and (4) overall experiences with the flipped method. The sections on learning experience and preferences for course materials and assessment tools utilized in the course were set up on a Likert scale (1-5) and the overall means for each question were calculated. A higher score indicated the tool or materials were more helpful to learning while a lower score indicated the inverse. Descriptive statistics, one way Analysis of Variance (ANOVA) and Spearman bivariate correlation analyses were conducted to evaluate the survey feedback. Bivariate correlation was used to gauge general relationships between individual variables and ANOVA was conducted to help determine specific relationships revealed by the bivariate analysis. These statistics sought to measure if student level (e.g. freshman, sophomore, etc…), time spent on eCampus or major effected changes in grades. The time each student spent on eCampus was extracted from the Blackboard database, which collected information on time logged in and log-in amounts.

Results

Overall preferences

The majority of students enrolled in this course reported positive attitudes in regards to the effectiveness of flipped teaching. In fact, over 80% of students' preferred online assessment over in-class assessment and students' past experience with taking online courses was significant for their expected grade at the 0.1 level (see Table 1). This suggests that most students who had taken online based courses before, expected higher grades at the beginning of the semester than they ended up receiving.

Initially, ANOVA was used to statistically measure the difference among year levels in regards to grade change and no significant difference was found. ANOVA results on students' grades by major provided showed that the means were not all same at a .05 significance level, but failed to detect a significant difference in the post-hoc comparison (see Table 2). The post-hoc test on the ANOVA showed that the differences between student grade groups divided in to A and C, and between group B and C were significantly different ($p < .05$), while the differences of other groups were not. This indicates that students receiving a grade of A or B spent more time on eCampus than the students who received a C, showing a positive influence of time spent on eCampus on students' final grades (see Table 3).

Information communication

Flipping lecture sessions did not appear to have much perceived influence on increasing communication between students (see Table 4). Among students surveyed, 59 students (33.2%) disagreed and 48 students (26.3%) agreed there were greater opportunities to communicate with other students using the flipped model. The ability to increase student-professor interaction seemed to increase using the flipped model while inter-student interaction showed little to no increase. Survey results confirm over two-thirds (69%) of the

Table 1. Description of Survey Participants.

	Participants	Unit	Size	Freq. (%)
Gender	Female		183	75 (41.0%)
	Male			108 (59.0%)
Level	Freshman		183	52 (28.4%)
	Sophomore			49 (26.8%)
	Junior			48 (26.2%)
	Senior and above (5th year)			34 (18.6%)
Major	University Studies in Architecture		183	89 (47.1%)
	Landscape Architecture			30 (15.9%)
	Construction Science			18 (9.5%)
	Environmental Design - Architectural Studies			11 (5.8%)
	Urban and Regional Planning			4 (2.1%)
	Other [a]			31 (19.6%)
Blackboard Acknowledgement Prior to the Course	Blackboard Acknowledge-ment	Yes	183	75 (41.0%)
		No		108 (59.0%)
	Blackboard Experience	Yes	183	58 (31.7%)
		No		125 (68.3%)
	Blackboard Usage Acknowledgement in Class	Yes	183	29 (15.8%)
		No		155 (84.2%)
	Other Online Course Experience	Yes	183	84 (45.9%)
		No		99 (54.1%)
Module Usage	Module Usage as Guided [b]	Yes	183	149 (81.4%)
		No		34 (18.6%)
	Module Completion	All Three	178	149 (83.7%)
		Two		22 (12.4%)
		One		5 (2.8%)
		None		2 (1.1%)
	Discussion Participation [c]	Fully Completed	178	680 (63.7%)
		Partially Participated		11 (1.0%)
		Missed		377 (35.3%)
	Time Spent on Blackboard	Hour	180	108.18
Knowledge Acquisition	Grade Expected to Receive	A	183	85 (46.4%)
		B		79 (43.2%)
		C		17 (9.3%)
		D		2 (1.1%)

Data Source: eCampus platform (Module Completion, Discussion Participation, Time Spent on Blackboard, and Grade) Self-reported survey (Gender, Level, Major, Blackboard acknowledgment prior to the course, Module usage as guided, and Grade expected to receive)

[a] Other non-related majors are categorized into one group.

[b] A likert-scale question ("I did no t use the module before class, although I was supposed to") was converted. Yes = Strongly disagree, Disagree, and Neither agree nor disagree, No = Strongly agree and agree

[c] Students were assigned to complete 6 discussion boards (total 1068 responses).

Table 2. Students' Grades by Enrolled Year and Major. [a]

Variable	Year				ANOVA	Major			ANOVA
	Fresh. (*N*=55)	Soph. (*N*=59)	Junior (*N*=35)	Senior (*N*=31)		Architecture (*N*=35)	USAR (*N*=107)	Other (*N*=38)	
Grades [b]	2.8 ± 1.22	2.73 ± .98	2.65 ± 1.08	2.71 ± 1.22	*F*=0.12 *P*=0.9459	3.03 ± .78	2.56 ± 1.17	2.95 ± 1.14	*F*=3.31 *P*=0.0387*

[a] Students' majors are grouped into three based on the relevance of the lecture topic
[b] 4=A, 3=B, 2=C, 1=D, 0=F
* significant at the 0.05 level.

Table 3. Students' Time Spent on Blackboard by Grade Groups.

Variable	Mean ± SD					ANOVA	Comparison Group
	A (N=49)	B (N=69)	C (N=36)	D(N=17)	F(N=9)		
Time Spent on Black-board [a]	124.76 ± 57.59	121.16 ± 62.67	81.15 ± 41.69	82.78 ± 34.34	74.49 ± 53.56	F=6.00 P=0.000**	A Vs B A Vs C** A Vs D A Vs F B Vs C** B Vs D B Vs F C Vs D C Vs F D Vs F

[a] Time each student spent on Blackboard was recorded on the eCampus platform.
Unit=Hour
Grade Groups are typical final grades for the course (A,B, C,D, or F)
** Correlation is significant at the 0.05 level.

students believed the instructional delivery method did not limit their interaction with the professor. Flipped teaching could not, however, necessarily be shown to be a more engaging style of teaching than the traditional classroom with 47.0% of the total students agreeing that flipped teaching was more engaging and only 20.2% disagreeing.

Information accessibility

Information delivered by traditional teaching methods such as in-class PowerPoint delivery was positively reviewed by 61.6% students (see Table 4). Only 2.2% of students thought the in-class PowerPoint lectures were irrelevant to the course while 88.5% confirmed their usefulness. In the same context, 6.5% of students believed the in-class cinematic screenings to be irrelevant while a majority 62.9% of students thought them to be helpful. Simultaneously, information delivered by flipped teaching methods such as online modules and in-class question feedback were considered helpful by 78.7% of the students, over 15% higher than the traditional method review (see Table 4). Assigned readings were considered relatively less helpful by students. Course materials appeared to be viewed easily by most students in a multitude of environments. A majority of the stu-

dents attempted flipped materials at their homes (89.6%) with some taking them in more public areas such as libraries or study halls due to the support of existing technical equipment in these locations (see Table 5).

While the utilized materials were rated helpful overall and accessibility appeared to be a minor issue, technical problems can be a major obstacle to flipped teaching (Straumsheim, 2013). Around 14% of students reported internet connection was a primary problem with 7% experiencing glitches when interacting with the modules. These issues resulted in students having to re-take modules which may have been submitted early due primarily to internet connection and/or web browser incompatibilities. The issues were typically based on software compatibility, not user error. Unlike the common concerns of technical accessibility, only 2.2% reported unfamiliarity with the software utilized in the flipped assignments (see Table 5).

Table 4. Course Materials and Assessment Tools Perceived Effectiveness.

Question		Irrelevant to learning	Not helpful	Neutral	Somewhat helpful	Very helpful	Mean
Course Materials							
Traditional Teaching	In-class PowerPoint lectures	2 (1.1%)	2 (1.1%)	17 (9.3%)	65 (35.5%)	97 (53.0%)	4.38
	In-class Cinematic screenings	1 (0.5%)	11 (6.0%)	56 (30.6%)	68 (37.2%)	47 (25.7%)	3.81
	Readings	10 (5.5%)	23 (12.6%)	89 (48.6%)	41 (22.4%)	20 (10.9%)	3.21
Flipped Teaching	In-class questioning and feedback using PowerPoint slides	2 (1.1%)	3 (1.6%)	24 (13.1%)	66 (36.1%)	88 (48.1%)	4.28
	Blackboard online modules	2 (1.1%)	5 (2.7%)	30 (16.4%)	71 (38.8%)	75 (41.0%)	4.16
	Flipped course discussion	6 (3.3%)	11 (6.0%)	34 (18.6%)	72 (39.3%)	60 (32.8%)	3.92
Other	Help from the instructors after class	2 (1.1%)	1 (0.5%)	76 (41.5%)	46 (25.2%)	58 (31.7%)	3.86
	YouTube videos	4 (2.2%)	14 (7.7%)	56 (30.6%)	76 (41.5%)	33 (18.0%)	3.66
Assessment Tools							
Traditional Teaching	Online exams	3 (1.7%)	0 (0.0%)	13 (7.1%)	56 (30.6%)	111 (60.7%)	4.49
	Quizzes	6 (3.3%)	5 (2.7%)	28 (15.3%)	79 (43.2%)	65 (35.5%)	4.05
Flipped Teaching	Blackboard test your knowledge modules	2 (1.1%)	1 (0.5%)	22 (12.0%)	82 (44.8%)	76 (41.6%)	4.25
	Flipped course questions	5 (2.7%)	5 (2.7%)	23 (12.6%)	82 (44.8%)	68 (37.2%)	4.11
	Discussion forums	5 (2.7%)	20 (10.9%)	79 (43.2%)	43 (23.5%)	36 (19.7%)	3.46

Cell entries represent the frequency (proportion) of respondents

Table 5. Individual Experiences of Flipped Course Materials.

Question	Response	Freq. (%)
Reason why "flipped" assignments were not completed on time	I had internet connection problems	26 (14.2%)
	There were glitches in the interface	12 (6.6%)
	I was unfamiliar with the software used	4 (2.2%)
Place Flipped Course was taken	At home/your room	164 (89.6%)
	In library	11 (6.0%)
	In a designated study area (i.e. Study Hall)	4 (2.2%)
	Other	4 (2.2%)
Average Stopping Time of Flipped Course Material	Never	11 (6.0%)
	Once	34 (18.6%)
	2-4 Times	81 (44.3%)
	5-7 Times	31 (16.9%)
	More than 7 times	26 (14.2%)
Reason why "flipped" assignments were not completed on time	I completed all assignments on time	84 (45.9%)
	The length of the materials covered was too long to hold my attention	16 (8.7%)
	I forgot/was unaware of the deadlines	28 (15.3%)
Average View Time of Flipped Course Material	Never	2 (1.1%)
	Once	53 (29.6%)
	2-3 times	100 (55.9%)
	More than 3 times	24 (13.4%)
Satisfaction with the way the course was delivered	Yes	173 (94.5%)
	No	10 (5.5%)

Information stimulation

For students who completed the flipped course assignments on time, the self-paced approach slightly increased stimulation. Flipped teaching was primarily helpful for those students seeking courses which allow them to learn at their own pace. A majority of the students (55.2%) agreed motivation to learn in the flipped classroom increased and 84.7% enjoyed the self-pacing capabilities of the flipped material. However, 12.6% did appear to be de-motivated by the approach (see Table 6). Self-motivation of students was increased by the allowance of students to stop the materials when necessary and return to it at a later time. Around 75% of the students in the course stopped the flipped materials more than once with 44.3% pausing the materials between 2-4 times and only 6% continuing without stopping the material (see Table 6).

Information interaction

Sixty-nine percent of the students viewed the flipped material two or more times, suggesting that students accessed the information repetitiously and with relative ease. This

Table 6. Survey Results on the Learning Experience of Flipped Teaching.

Question	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Mean
Information Communication						
The "flipped" courses did not limit my interaction with the professor.	3 (1.6%)	4 (2.2%)	39 (21.3%)	97 (53.0%)	40 (21.9%)	3.91
The "flipped classroom" is more engaging than the traditional classroom.	7 (3.8%)	30 (16.4%)	60 (32.8%)	55 (30.1%)	31 (16.9%)	3.40
The "flipped classroom" allows me greater opportunities to communicate with other students.	9 (4.9%)	50 (27.3%)	76 (41.5%)	32 (17.5%)	16 (8.8%)	2.98
Information Accessibility						
I like the ability to self-pace my learning with "flipped courses".	0 (0.0%)	6 (3.3%)	22 (12.0%)	74 (40.4%)	81 (44.3%)	4.26
I am more motivated to learn in the "flipped classroom".	4 (2.2%)	19 (10.4%)	59 (32.2%)	57 (31.1%)	44 (24.1%)	3.64
Information Accumulation						
Overall, "flipped classroom" enhanced my learning in this course.	1 (0.5%)	3 (1.6%)	34 (18.6%)	83 (45.4%)	62 (33.9%)	4.10
The "flipped classroom" improved my learning about the history of landscape architecture.	1 (0.5%)	8 (4.4%)	32 (17.5%)	93 (50.8%)	49 (26.8%)	3.99
I wish more instructors used the "flipped or inverted classroom" model.	6 (3.3%)	13 (7.1%)	28 (15.3%)	79 (43.2%)	57 (31.1%)	3.92

Cell entries represent the frequency (proportion) of respondents

suggests that, for the most part, students were able to interact with the information as needed. Simultaneously, 94.5% of the students said they were satisfied with the way the course was delivered (see Table 6) indicating not only that material accessibility was a minor issue, but interaction with the information available was frequent and enjoyable. Positive attitudes toward course materials and quality and interactivity of the materials utilized helped reinforce information interaction.

Statistically, interaction with course information was shown to be positively influential towards perceived knowledge acquisition. A Spearman bivariate correlation and one-way ANOVA were conducted to statistically measure this relationship, examining data on time students' spent on eCampus and actual grades. The Spearman bivariate correlation between students' grades (A, B, C, D, or F) and time spent (in hours) on eCampus indicated the degree to which students who utilized eCampus more are were likely to get a higher grade. Results showed that changes in time spent on eCampus were positively correlated with changes in final grades ($r(180) = .319$, $p < .001$) (see Table 7). Specifically, students who received an A or B spent more than 120 hours on average on eCampus whereas students who received a C or D spent only around 80 hours. The one-way

ANOVA was results signified that not all grade groups had the same average time spent on eCampus at a .01 significance level.

Information accumulation

Assessment tools of flipped teaching were compared with traditional assessment tools for comparison of impact. Although many students considered online exams more helpful than other tools utilized in the course, the tools associated with flipped teaching were all considered highly beneficial, with a mean rating of 4.25 for module questioning and 4.11 for in-class formative questioning (see Table 4). Discussion forums and question submissions appeared to be less effective with most of the incomplete assignments by students occurring on these portions. Over the entire semester, only 63.7% students completed all question pre-class posting assignments for discussion, with around 35.3% missing one or more class assignments. Only 4.9% of the students believed their learning was not improved through the flipped method (see Table 6). While the number of views of course materials was high, suggesting an elevated motivation by students, the flipped teaching model did show some issues with students meeting deadlines. More than 15% of the students missed certain due dates of assigned flipped materials, with only 45.9% completing all flipped assignments on time during the semester. Nearly 84% of students had grades for all online lecture modules with only 3.9% completing less than 50% of the entire modules.

Conclusions and Discussion

This study utilized five measures to assess the perceived effects of flipped teaching on knowledge acquisition in a large lecture format undergraduate university core curriculum course. It was assumed that if a student perceived that they were learning more and were benefiting from the flipped format, they were likely to have higher levels of engagement and have a greater value of the course, leading to better performance and increased rates of persistence. Based on the survey results, information communication was considered the most positively perceived variable in class while information accessibility and information stimulation were the primary positively perceived factors outside of class. Increased accessibility and stimulation can result in increases in interaction with course materials such as lectures, readings, videos, assignments, quizzes, tests, readings, or any other course needs/innovations. An argument against this flipped teaching may be that the approach limits person to person interactivity in the classroom. However, results of this study show an increase student-professor interaction through the flipped model while inter-student interaction showed little to no perceived influence. Overall perceived effects of flipped teaching on each variable are indicated briefly in Table 7**.**

Results suggest some advantages and disadvantages to using flipped teaching. The approach's greatest advantage is that it allows students to pace themselves, be self-organizational, access information constantly with the ability to pause and rewind. Computer issues, software incompatibility, or browser connection problems can, however, cause more complications than standard homework in some cases. Such technical glitches may also result in lower scores for students. The combination of visual, auditory, and

Table 7. Summary of Variables used to Measure Effects of Flipped Teaching on Knowledge Acquisition

Survey Results	Information Communication	Information Accessibility	Information Stimulation	Information Interaction	Information Accumulation
Positive	Interaction between student and professor increased using the flipped model.	Flipped teaching material (as well as in-class) material were both considered helpful.	The self-paced approach appeared to increase stimulation and motivation. Class materials were viewed easily in multiple environments	Students accessed the information easily and were able to interact with the information as needed.	Flipped teaching tools were considered helpful for increasing knowledge Most students considered the flipped classroom as a positive learning experience
Negative	Inter-student interaction showed little to no influence.	Assigned readings were considered relatively less helpful than other course materials.	Many of the students missed the deadline due to the distraction and unawareness.	Technical problems such as glitches on the modules were a major issue for students.	Discussion forums appeared to be less effective with most of the incomplete assignments.

interactive learning tools housed in a singular platform tends to increase the retention of information, encouraging in-class discussion and pre-class preparation. While interaction with instructor and classmates can be limited by the approach, the ability to ask questions in class for longer periods can alleviate related issues involved with the disadvantage. For example, if the student has done the assignment and covered the necessary materials for a particular course, that preparation will allow for specific questions to be posed during the designated time. Therefore the approach is highly dependent upon student motivation. There is also a higher potential for distractions when students view the material outside of class. The ability to be able to re-view materials can alleviate this issue somewhat, but can sometimes cause more time to be used for information review than a face-to-face class.

Statistical analyses showed that spending more time on eCampus resulted in significantly higher grade improvement when using the flipped model. Gender, major, and year level proved not to be significant factors. This suggests that the approach can be applied to multiple disciplines, fields, or majors, and is not specific to design based disciplines. The interactive modules and multiple instructional deliver methods used in the course catered to a wealth of learning styles. Thus, a new need presented by this research is for instructors to develop methods to increase student time spent on the eCampus or other platforms for classroom technology support. More interactive methods to for students to digest course materials are necessary and innovative ways to encourage connection between student's and course material are necessary.

Formative assessment tools and a mixture of differing media for instructional delivery methods proved to be the key to achieving

an effective flipped course. Making the lectures available for studying purposes alongside the interactive modules with built in consistent formative questioning helped to increase knowledge acquisition. Issues such as internet access and web compatibility still plague the inverted method, but overall accessibility to course materials remained relatively high. The technical issues reported by students will continue as long as flipped courses utilize online or computer-based materials. This issue may become less crucial later, but it proves to be a major obstacle to acquiring knowledge and could potentially prevent a stable environment for flipped courses. Increases in internet network coverage and connection speeds will eventually eliminate many of these quandaries. However, this issue is still a limitation that requires further research. Also, flipped teaching appears to be an approach which works better for self-motivated students. The use of a multitude of numerous minor assignments, such as discussion posts or question submission assignments, can sometimes be overlooked by students who are less self-motivated.

In summary, this research creates an initial direct connection between the flipped classroom and perceived increase in student learning. The inverted approach can enhance student learning, but adherence to what the research shows when organizing a course is a salient factor in its enhancement possibilities. Student preference for online assessment over in-class assessment and the overall positive reaction to the flipped style suggests that the pedagogical shift towards the integration of online materials and hybrid courses is a necessary one. This position is reinforced through the finding that videos were preferred over readings, signifying a shift in learning styles from students.

Students of the current era are more engaged with technology than the previous generation and the hope is that education and developing technology can be used as a source to facilitate the teaching-learning process (Halili & Zainuddin, 2015). The flipped learning process makes students take responsibility for their own learning at their own pace. Still, there is much to learn about flipped instruction. First, do students learn more and retain more over the long run when taught with the flipped approach? Because this paper only looked at student learning perceptions at a given point, the question of learning and retaining information over the long run is not fully answered. While the perception of knowledge acquisition shows an increase at a single point in a single course, long-term learning requires much more comprehensive, longitudinal and comparative methods for evaluation. Second, this research did not take into account the impact of flipped learning on student-teacher interaction outside of class. Those not practicing flipped approaches make up for some of this interaction and engagement in courses with higher levels of one on one interaction, during office hours or in meetings with students. While flipped classes afford more student-instructor interaction in class, there is little research shown about student-instructor interaction outside of class. These and other avenues of exploration about the flipped method merit inquiry moving forward to adequately assess the approaches' true impact.

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