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I am submitting herewith a dissertation written by John Creighton Cummins entitled "College Student Engagement Patterns in Small Group Learning Activities Conducted in Courses Organized using a Flipped Learning Instructional Pedagogy." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

Michael Waugh, Major Professor

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(Original signatures are on file with official student records.)

College Student Engagement Patterns in Small Group Learning Activities Conducted in Courses Organized using a Flipped Learning Instructional Pedagogy

A Dissertation Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

John Creighton Cummins
May 2016

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Dedication

To my sweet wife, Sharon Starr Cummins. Sharon, you stood by me through all of the course work, proposal iterations, proposal defense, dissertation writing, and dissertation defense. Thank you for your understanding, love, friendship, and continual support, darling. Without your help I would never have finished.

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Abstract

The purpose of this study was to examine student engagement patterns in small-group learning activities conducted in courses organized using a Flipped Learning Instructional Pedagogy (FLIP) at the University of Tennessee at Knoxville (UTK). A literature search on FLIP revealed no papers that examined student engagement at a fine-grained level. Classrooms were examined using an observational tool developed specifically for the examination of fine-grained student engagement. In order to observe overt engagement patterns of students during active learning in small groups, an observation tool was designed by combining an engagement framework with an in-class activity inventory.The Complex Level of Overt Student Engagement/Student-Centered Active-learning Exercises (CLOSE SCALE) tool was the result of this combination. The CLOSE SCALE tool was used to detect fine-grained student engagement levels on a minute-by-minute basis during the small-group activities. Eight different courses which sought to engage students in small-group active-learning were observed. Class sizes ranged from 12 to 41 students with group sizes of 2 to 12 individuals. The study focused on four specific research questions to determine: (a) the typical proportion of time spent in small-group activities during flipped classroom sessions, (b) the statistical significance of student engagement variations across levels of activity complexity, (c) the statistical significance of student engagement variations across levels of activity complexity across small-group sizes, and, (d) the correlation of instructors' estimates of engagement with an engagement complexity moment calculated from observations of students' group work. Across the eight observed classes students typically spent approximately 50%, of their in-class time in small-group activities. Chi-square tests determined that student engagement levels were statistically significantly different across activity level and group size. Instructors' estimates of student engagement during small-group activities were moderately correlated to the complexity moments calculated from researcher observations of specific small groups within the class. The CLOSE SCALE was found to be a useful tool for recording fine-grained student engagement during small-group activities in FLIP classrooms. This tool may be useful for future in-class observations and determinations of student engagement in both FLIP and non-FLIP classrooms.

Preface

This dissertation is submitted for the degree of Doctor of Philosophy at the University of Tennessee. The observational research that follows was conducted under the supervision of Professor Michael Waugh, in the Department of Educational Psychology, University of Tennessee, between January and March 2016. This work is to the best of my knowledge original, except where acknowledgments and references are made to previous work. This dissertation contains less than 30,000 words excluding appendices, references, and tables.

Table of Contents

Chapter 1 Introduction 1

The Problem of Student Engagement in Small Groups 8

Background and Need 10

The Purpose of a Study on Student Engagement Patterns 10

Theoretical Perspective 11

Importance of a Study on Student Engagement Patterns 14

Research Questions 16

Delimitations 17

Limitations 18

Definition of Important Terms 19

Summary 20

Chapter 2 Review of the Literature 22

A Flipped Learning Instructional Pedagogy 22

Definition of a FLIP. 23
History of FLIP. 25
Theoretical perspective of FLIP. 28
Variations of FLIP. 31
Research in FLIP. 33
Summary of FLIP. 36

Active Learning 38

Definition of active learning. 38
Active learning strategies. 42
Theoretical perspective of active learning. 43
Student Engagement 46
Definition of student engaged learning. 46
Types of student engagement. 49
Research on engaged learning in FLIP. 52
Tools for measurement of classroom engagement. 52
Summary 53
Chapter 3 Materials and Methods 55
Observation Tool Development 55
Calculation of the complexity moment. 58
Research Questions and Rationale 61
Research question 1. 61
Research question 2. 62
Research question 3. 63
Research question 4. 63
Research Design 64
Research Hypotheses, Statistical Hypotheses, and Data Analyses 66
Research question 1. 66
Research question 2. 67
Research question 3. 68
Research question 4. 68
General Analyses Notes 69
Inter-rater reliability. 70
Observational Classroom Setting 71
Participant Selection and Description 71

Human Subjects Consideration 73

Clearance from IRB 74

Description of Observation Tools and Development 74

Research Method 76

Data Collection Process 77

Instructor data. 77
In-class data and observation protocol. 79

Summary 84

Chapter 4 Findings 85

Classroom Demographics 85

Small-group Observations 86

Inter-rater Reliability 86

Findings on Research Questions 87

Research question 1. 87
Research question 2. 88
Research question 3. 91
Research question 4. 91

Additional Findings 94

Interview findings. 94

Chapter 5 Discussion 96

Discussion of Questions 96

Research question 1. 97
Research question 2. 100
Research question 3. 102
Research question 4. 106

General Discussion on Student Engagement 107

M125. 108
SP300. 110
PS430. 111
PS331, PS438/538. 114
Summary of general discussion on engagement. 118

Flipped Learning Instructional Pedagogy Models 119

Conclusion 122

Directions for Future Research 125

List of References 128

Appendices 141

Appendix A: The Active Learning Inventory Tool © 2006 142

Appendix B: ICAP Framework with Examples of Learning Activities 143

Appendix C: Group Activities Added to SCALE 144

Appendix D: Overt Student Engagement Behaviors 147

Appendix E: The CLOSE SCALE Observation Instrument Checklist 148

Appendix F: Institutional Review Board Approval Letter 149

Appendix G: Informed Consent Statements 150

Appendix H: Pre-observational Instructor Interview Questions 154

Appendix I: Post-observational Instructor Interview Questions 155

Appendix J: Observational Direction of Small Groups.....156

Appendix K: Observational Raw Data with Minimum Instructor Interaction...157

Appendix L: Observational Raw Data with Instructor Interaction.....159

Appendix M: Raw Data for Inter-observer Reliability Calculation. 161

Appendix N: Pre-Observation Instructor Interviews.....162

Appendix O: Post-Observation Instructor Interviews 165

Vita 168

List of Tables

Table 1. Countries utilizing a FLIP model. 27
Table 2. Disciplines that utilize a FLIP model. 41
Table 3. Sampled courses. 85
Table 4. Frequency of small-group observations. 86
Table 5. Inter-rater reliability between the two observers.....87
Table 6. Small-group demographics during observations. 88
Table 7. Time in levels of engagement across activity complexity. 89
Table 8. Time in engagement across activity with instructor interactions.....90
Table 9. Time in levels of student engagement across group size.....92
Table 10. Time in levels of engagement across group size with instructor interactions 92
Table 11. Brief summary of instructor interviews. 94

List of Figures

Figure 1. Complexity moment calculation. 60
Figure 2. Engagement level of students across complexity of activity. 90
Figure 3. Engagement level across group size with instructor interactions.....93

Chapter 1

Introduction

There is mounting evidence that the lecture pedagogy does not provide students with adequate preparation for the requirements of the modern workplace (Cadle, 2015). Evidence is continually emerging that pedagogies that emphasize engaged, active-learning in the classroom can increase higher-order thinking in students and can prepare students more effectively to join the modern day workforce more effectively (Bristol, 2014; Cadle, 2015; Herold, Lynch, Ramnath, & Ramanathan, 2012; Ryan, 2013; Tattersall, 2015). Small-group activities have been developed for use in the classroom that will better engage students in learning. Research studies report that these activities have increased learning both in classrooms that utilize the lecture pedagogy and in those that do not (Hake, 1998; Jensen, Kummer, & Godoy, 2015; Konopka, Adaime, & Mosele, 2015; Mason, Shuman, & Cook, 2013; Michael, 2006; Wolff, Wagner, Poznanski, Schiller, & Santen, 2015; Yazedjian & Kolkhorst, 2007).

Active learning in the classroom can be more effective if students come to class prepared with basic concepts learned beforehand. Students who prepare for class by covering basic subject matter outside of the classroom can be ready to engage in active-learning situations during class. If students are cognitively engaged in these classroom activities, the theory of “active learning” predicts that these activities can lead to an increase in their higher-order thinking. Today,

students can acquire basic knowledge before coming to class through a variety of reading assignments, mini-lectures on video, or podcasts through the Internet. Students can then come to class and engage in meaningful collaboration through engagement in active-learning exercises. These experiences can improve the depth of thought and learning as well as aid in knowledge retention (Bonwell & Eison, 1991; Faust & Paulson, 1998; Prince, 2004). The traditional college student sits passively in a lecture-based course and receives information, then returns home with assignments to do after the lecture. The active pedagogy described above reverses this procedure. Basic instructional material normally covered in the classroom is instead covered before coming to class. And problems normally completed after lectures are encountered through active-learning experiences during class and often in small groups.

The procedure of inverting the times and places where basic content and homework is experienced by students is a pedagogical approach that goes by different names. It has been called *reverse instruction, flipping the class, the flipped classroom, the inverted classroom, flipped learning* and *inverted learning.* Throughout the remainder of this paper, this pedagogy will be referred to as a *Flipped Learning Instructional Pedagogy* (FLIP). The basic idea is that by flipping the homework-lecture pattern or sequence, students have more time for action-oriented activities in class which lead directly to more engaged participation and increased higher-order thinking (Cadle, 2015). In such a pedagogical approach, the classroom becomes focused on student-centered active-learning instead of

teacher-centered lecture. This pedagogy is not new. Also, there is not a single agreed upon FLIP model. The term FLIP is only used in a generic sense in this study. There are many variations of this pedagogy. Variations of a FLIP have been used for many years in fields such as law, language, and sociology, as students were asked to come prepared to engage in activities that center on case studies, practice problems, discussion or projects.

Recently, video hosting formats on the Internet such as Vimeo and YouTube have made the development and use of instructional videos much easier. Before these hosting formats were available the common approach to FLIP was to give a reading assignment, outline, or other homework to be done before class. The advent of the videocast and podcast has made it much easier to automate, augment and enrich the FLIP one-class experience. Flipped learning instructional pedagogy models vary enough that a discussion of what defines a FLIP is ongoing. The simplest agreed upon definition of the pedagogy refers to exchanging or reversing the order of lecture and applied work, such as homework (Bishop & Verleger, 2013; Cadle, 2015).

Teachers who use a FLIP generally want to encourage higher-order thinking among students, to reduce or eliminate lectures from the classroom, and to increase student engagement and collaboration, particularly in small groups (Berg, Ibrahim, Magaster, & Salbod, 2015; Bergmann & Sams, 2012; Dochy, de Rijdt, & Dyck, 2002; Gilboy, Heinerichs, & Pazzaglia, 2015; McLaughlin et al., 2014; Talbert, 2012; Waldrop & Bowdon, 2015). In a typical FLIP classroom

student learning goals are organized differently than in a typical lecture classroom. In Bloom's taxonomy of learning; remembering, understanding, and application are considered to be the lowest levels of learning (Bloom, Engelhart, Hill, & Krathwohl, 1956; Krathwohl, 2002). Using a lecture classroom pedagogy, these are often the highest levels achieved. With a FLIP these lower levels of Bloom's learning taxonomy are completed before coming to class by the students. Students learn basic concept materials, often by video, before coming to class. Using Bloom's taxonomy as a reference, learning at higher levels such as application, analysis and synthesis is enhanced by FLIP as students experience in-class active-learning exercises (Bloom et al., 1956; Gilboy et al., 2015; Kim, Kim, Khera, & Getman, 2014; Krathwohl, 2002). Two levels, publishing and reflecting, have been suggested to top out the revised Bloom's taxonomy (McCammon, 2013). McCammon (2013) added these levels to the Bloom's taxonomy of learning as he developed a variation of a FLIP for his classes.

A typical FLIP requires more work from students on the front end and, in a sense, more work load on teachers in the classroom. The main goal in a FLIP classroom is not to eliminate the transfer of knowledge and content to the learner but to front-load it thereby allowing the classroom to be more efficiently used for problem-based learning, discussion and problem solving and for collaborative processes and production. The process of flipping the classroom means to utilize an instructional model, a FLIP, which begins with specific student

preparation before class and continues with more active, engaged learning during class. If prior knowledge can be increased before class then the classroom can be used for higher-order thinking through engaged-learning collaborative activities. By contrast, the common lecture pedagogy has the instructor as the “sage on the stage” and the most active individual in the classroom. In a FLIP approach, the instructor becomes a “guide at the side” coaching and facilitating the students’ active-learning (Baker, 2000; Berg et al., 2015; Bergmann & Sams, 2012; Dochy et al., 2002; Gilboy et al., 2015; McLaughlin et al., 2014; Talbert, 2012; Waldrop & Bowdon, 2015).

Not only does a FLIP invert traditional lecture and homework, it also “flips” the instructor-focus to that of student-centered learning. Small groups of students often work collaboratively in the classroom with the FLIP approach. The hope is that by working in small groups students will become actively engaged in cognitive learning together in an interactive fashion that will increase overall learning (Moffett & Mill, 2014; Prince, 2004).

Flipped classrooms in their most recent form have been around for about 15 years (Baker, 2000; Bergmann & Sams, 2012; Lage, Platt, & Treglia, 2000a; Morgan & Bergman, 2014). The Internet, videos, and podcasts, have resulted in a rapid increase in the use of FLIP. This gives students the flexibility to view or listen to basic concepts and materials at their own pace and time before coming to class (Long, Logan, & Waugh, 2014).

A FLIP creates an educational system that Kim et al. (2014) describe as, “student-centered learning environments in which students are actively engaged in higher-order tasks and taking charge of their own learning." The FLIP approach allows an instructor, freed from the lectern, to physically move around the classroom. This is particularly helpful for students who need coaching on difficult concepts or problem-solving (Berg et al., 2015; Bergmann & Sams, 2012; Berrett, 2012). The instructor can become a coach or “guide by the side” to work closely with students to address individual needs (Baker, 2000).

Besides “homework” and problem solving being done in the classroom with FLIP, other Active-learning (AL) exercises may occur in the classroom such as discussions, peer teaching, collaborative learning in small groups, problem-based learning, role-play, peer review, concept map development, and discovery learning (Ryan, 2013). A general implication by those involved in AL research is that AL exercises lead to active engagement by the students. This engagement, in turn, is generally assumed to lead to higher-order thinking.

The actual use of the term FLIP started with the Chemistry and Physics courses at the high school level. Initially, videos were sent home in order to try to help students that were behind in these courses and the students viewing the videos improved so rapidly that the instructors decided to try “flipping” their classes with videos. Flipped Learning Instructional Pedagogy models have rapidly entered K-12 schools around the world. Now a FLIP is common in higher education situations as well (Bergmann & Sams, 2012; Gannod, Burge, &

Helmick, 2008; Talbert, 2012; Waldrop & Bowdon, 2015). A major reason given for utilizing a FLIP is for the promotion of engaged active-learning. This AL theory posits that the result of active-learning is higher-order, deeper, richer thinking; and this, is often a result of collaborative group work (Kim et al., 2014). Early research studies in FLIP examined affective behaviors and student perceptions of FLIP, in single-group study designs. Some recent studies have examined actual student performance but relatively little has been done to show how a FLIP might influence student achievement (Bishop & Verleger, 2013; Clark, 2015; Gilboy et al., 2015). Similarly, few studies have researched engaged, active-learning in the classroom. Specifically how might small group size affect the impact of a FLIP approach? A better understanding of the relationship between small-group size and overt, student engagement in learning activities during FLIP is needed.

While some research on active learning in a FLIP has been attempted, little has been done specifically to examine overt engagement levels of students in active-learning exercises. Most of it has been at the larger-grained levels such as student continuation in school, completion of tasks, class enrollment, and overall college success (Atnip, 2015; Bormann, 2014). There are no studies to date of the relationships among student engagement behaviors in active-learning instructional settings that use fine-grained, overt, measurable engagement of students' actions in a FLIP context. Student engagement research has often been centered on precursors to engagement such as motivational or emotional

variables rather than with overt engaged behavior of students in the learning process (Chi & Wylie, 2014; Chi, 2009; Chi, 2011; Menekse, Stump, Krause, & Chi, 2013). Measures of engagement in learning tasks normally involve the bivariate measurements of off-task and on-task behaviors avoiding finer gradations of on-task engagement (Matcha & Rambli, 2016).

The Problem of Student Engagement in Small Groups

There are two assumptions that are often shared by instructors and researchers involved with active learning among students within small groups. The assumptions are: (a) that students in small groups involved in Student-Centered Active-Learning Exercises (SCALE) will be behaviorally engaged in the learning activities; and (b) that small-group collaborations will lead to higher Complexity Levels of Overt Student Engagement (CLOSE) in SCALE. An examination of overt student engagement behaviors and patterns in learning exercises in the small groups can lend credence to these assumed points in AL. Small groups of students who are engaged in AL exercises are assumed by researchers to engage in increased higher-order thinking (HOT) and therefore increased learning (Christiansen & Salm, 2015). Christiansen and Salm (2015) note that, “student engagement is much more complicated than just putting people into groups and having them learn together”. There is an assumption that SCALE will lead to the increased complexity of cognitive student engagement necessary for learning to take place.

The overt cognitive engagement of students has not been observed in enough detail to see if active-learning events trigger increased student engagement (Chi & Wylie, 2014; Chi, 2011). Very little research attention has been paid to detailed examinations of in-class, engaged, active-learning (AL). A review of the relevant literature for this research study revealed no prior studies that addressed this issue with respect to FLIP classrooms.

A common reason for using a FLIP in the first place is to engage students in AL. The terms active-learning and engagement are often interchanged (Bates & Galloway, 2012; Bormann, 2014; Clark, 2015; Gilboy et al., 2015; Harvey, 2014; Kim et al., 2014; Long, Logan, Waugh, & Cummins, 2013; McLaughlin et al., 2013; Menekse et al., 2013; Roehl, 2013; Sams & Warneke, 2013; Trogden, 2014). Though the terms active-learning and engagement are often used interchangeably, many researchers agree that they are not synonymous. It is often implied that when active learning is present, student engagement will be present as well. However, students may or may not be engaged in a learning exercise. Students can be active but not engaged. Ultimately, engagement in the AL exercises must occur for learning to take place (Chi & Wylie, 2014; Menekse et al., 2013).

The present observational case study examined engaged AL within the context of FLIP classrooms. The developed observational tool used in this study was based upon an AL framework and an inventory of AL activities previously developed by others (Chi & Wylie, 2014; Van Amburgh, Devlin, Kirwin, &

Qualters, 2007). This observational tool allowed for a fine-grained examination of the overt engaged behaviors of students in small groups.

Results from this study provide a detailed snapshot of levels of cognitive student engagement in active-learning exercises in FLIP classrooms. This study provides insight into student engagement within different sized small groups using a FLIP. If the theory of AL has merit, an increase of student engagement in the small group activities will associate with increased higher-order thinking (HOT) and increased student learning.

Background and Need

A paucity of data exists from fine-grained examinations of cognitive engagement by students in active-learning situations in FLIP classrooms. Because of this lack, there is a need for a detailed observational study that focuses on overt student engagement in student-centered active-learning exercises in small group settings. While there is a general lack here, a FLIP classroom, with its emphasis on small group active-learning, provides an ideal setting for such a study. Research on small group size in relation to engaged active-learning is also lacking. A FLIP classroom provides a good context for an examination of this variable.

The Purpose of a Study on Student Engagement Patterns

The primary purpose of this study was to examine student engagement patterns and behaviors during active-learning exercises within small-groups, in

higher education courses that utilized a flipped learning instructional pedagogy (FLIP). In order to do this it was necessary to focus on the variables of small-group size, student overt behavioral engagement in learning activities, and on the specific activities designed for that learning. There are gaps in the research regarding the relationships between small group size, student engagement, and student-centered active-learning exercises (SCALE) in FLIP approaches.

By looking at several different classes where instructors used a FLIP, it was hoped that through an observational case study, results would indicate the degree to which students were engaged in SCALE. The findings from a study of student engagement patterns in small group learning activities should provide increased knowledge of interrelationships among these critical variables related to students' learning. Feedback to instructors can perhaps lead toward better instructional design of FLIP classrooms in the future. Results from this study can provide support for future research into the complexity of student engagement in small groups in FLIP classrooms in particular, and in other active-learning contexts in general.

Theoretical Perspective

The theory of engaged active-learning (AL) embraces the idea that AL leads to higher-order thinking (Bonwell & Eison, 1991; Bonwell & Sutherland, 1996; Prince, 2004). If AL does lead to HOT this is better than students passively

receiving information in traditional lecture formats which do not seem to lead to HOT (Bonwell & Sutherland, 1996).

Bonwell and Southerland (1996) note that students learn best when engaged in AL and that this is not likely to occur through passive reception of knowledge conveyed in a typical lecture format. Students should be actively engaged in the learning process. Bonwell and Southerland (1996) developed a conceptual framework for instructors to use AL in their classes according to their styles of teaching and the learning objectives of their courses. They promote a wide variety of AL strategies that could be used in classrooms, including cooperative learning and other AL techniques. Common barriers to AL in lecture approaches mentioned by Bonwell and Southerland (1996) include the ability to cover content and a general lack of materials. A FLIP can alleviate both of these barriers by off-loading basic content to pre-class. The format of pre-class materials may take the form of videos, podcasts, readings, as well as several other formats of learning materials currently available on the Internet (Bonwell & Sutherland, 1996).

The existing research on FLIP models points to a basic assumption that shifting the student-content interaction that normally occurs in lectures to pre-class activities will allow for more in-class time for active engagement with the content thus causing students to think more deeply, leading to HOT. These in-class activities are often developed as collaborative group learning efforts (Bonwell & Sutherland, 1996; McLaughlin et al., 2014; Prince, 2004). Many AL

strategies have been developed to aid in learning, including teamwork, cooperative learning, debates, self-reflection, case studies, concept mapping, small-group presentations, peer teaching, and jigsaw (Bonwell & Sutherland, 1996; McLaughlin et al., 2014; Prince, 2004; Van Amburgh et al., 2007). The theory of AL predicts that AL in the classroom will increase as interactions and engagement between students and instructors increase. This is particularly true in small groups. According to the theory of AL, AL leads to HOT and FLIP can provide affordances for this to happen (Bormann, 2014).

Within the traditional lecture pedagogy there are few opportunities for student engagement. But a FLIP classroom normally uses small-group learning exercises that are designed to encourage engagement. When an instructor breaks a class into such groupings using student-centered active-learning exercises, the possibilities for overt student engagement should be increased and HOT should occur.

Overt student engagement was measured in this study. This measurement was in relationship to specific AL exercises within various small groups of students. The student engagement variable was designated by complexity level of student engagement (CLOSE). The AL exercise variable was designated as student complexity active-learning exercises (SCALE).

Importance of a Study on Student Engagement Patterns

Most studies on student engagement in student-centered active-learning exercises (SCALE) to this point have dealt with either motivational, emotional, or large-grained behavioral aspects of engagement (Chi & Wylie, 2014; Chi, 2011). While these aspects of student engagement may be important for AL to occur, by definition, student engagement must involve observable engaged behaviors in learning situations (Bonwell & Eison, 1991; Bonwell & Sutherland, 1996; Fredricks, Blumenfeld, & Paris, 2004). Active learning and engagement are often considered to be one and the same. There is a general assumption shared by those involved in AL theory that AL activities will result in students engaged in learning (Chee & Wong, 2015; Grier-Reed, Appleton, Rodriguez, Ganuza, & Reschly, 2012; Young, Robinson, & Alberts, 2009). AL has even been called “interactive-engagement” (Hake, 1998). Hake (1998) showed in an analysis of over 62 introductory physics courses that used AL techniques, that learning gains nearly doubled with these techniques. It can be implied that in those courses students were engaged and active in the engagement based upon the results, however, the degree of overt student engagement remains unknown without an objective measure of engagement by trained observers.

Other types of engagement often mentioned are motivational and behavioral. Motivational studies examine student attitudes and interest in getting involved in learning. Motivational engagement then is a precursor to engagement but is not actual overt student engagement in learning. Motivational engagement may lead

to student engagement but is not in-and-of-itself overt engagement. Emotional aspects of motivation deal with positive and negative reactions to variables in a classroom but, again, are not overt engagement. Finally, behavioral engagements that deal with large-grained measures such as attendance or homework are not the type of behaviors that show overt learning engagement (Chi & Wylie, 2014). While there have been behavioral, performance, affective and perceptual types of studies in conducted on FLIP models, no research to date has looked at fine-grained overt student engagement within SCALE in small groups in FLIP. Some research has been done in student engagement on some larger-grained and hard-to-measure ideas such as thoughtfulness and willingness to learn and perform skills (Fredricks et al., 2004). However, there is a need to measure overt student engagement during small group SCALE. Flipped learning instructional pedagogy classrooms offer an instructional setting in which this can be accomplished (Chi & Wylie, 2014).

This observational study was designed to examine fine-grained student engagement behavioral patterns in student-centered active-learning exercises. Engagement as shown by overt behaviors during learning activities should provide insight into the possible amount of cognitive engagement that may be occurring within students' minds. Students are the future workforce. They must know how to think critically, how to work collaboratively, how to interact effectively and how to engage in active learning (Cadle, 2015). If fine-grained measures show that student engagement increases with complexity of student-

centered active-learning exercises in small groups, it should be documented for the future and may help to validate the theory of AL. A FLIP classroom allows for a study of student engagement with active-learning strategies in small groups. A demonstration of a FLIP observational checklist that can be used by observers in the classroom should be documented for the future. This checklist could then be used by trained observers or instructors to determine student engagement levels in learning activities. Instructors can then take the knowledge about the levels of student engagement and potentially be able to increase engaged learning in a FLIP classroom. By adjusting the types of active-learning strategies they select, they may be able to develop improved student engagement in learning activities.

Research Questions

This study examined the following questions in the context of small group size in FLIP classrooms. The relationship between small groups of students and the complexity level of student engagement was examined. The relationship between the complexity of student-centered active-learning exercises (SCALE) and complexity levels of overt student engagement (CLOSE) was examined as well. This was done using an observational checklist developed for the study. The checklist was a combination of an established engagement framework and an active-learning behavioral scale. The framework and SCALE both have varying levels of complexity. With the understanding that a FLIP was to be implemented and that small groups of two or more students were to be observed ($n \geq 2$), this study addressed the following specific research questions:

1. What proportion of total class time in a FLIP classroom is typically spent in student-centered active-learning exercises (SCALE)?
2. Will students who participate in instructional activities classified at different levels of difficulty (as classified by the SCALE instrument) perform differently in terms of amount of time spent at different levels of overt student engagement as measured by the CLOSE instrument?
3. Will students in different sizes of small groups perform differently in terms of amount of time spent at different levels of overt student engagement as measured by the CLOSE instrument?
4. How do instructor estimates of whole class student engagement during small group activities correlate with student engagement as measured by the CLOSE instrument (complexity moment)?

Delimitations

This study was delimited to the observations of student engagement in small groups in FLIP classrooms that utilized specific AL strategies. Student engagement could be observed in small groups within instructional contexts of any sort that utilize AL strategies, but it was delimited in this study to FLIP because the nature of a FLIP is to use small groups to a larger degree than in most classrooms. Student engagement can also be observed in traditional lecture situations but, again, the frequency of small group breakouts is much reduced in those situations. The study was also delimited to the college classroom because of the ease to the researcher in accessing such a population.

Literature reviewed was delimited primarily to peer reviewed and scholarly materials. Observation was the chosen method in the study because interviews and surveys were felt to be too subjective. Two observational tools were utilized to the exclusion of others because: (a) only one tool discovered dealt with fine-grained observation of engaged learning, and; b) the other tool illustrated basic levels of active-learning strategies better than others. This study was also delimited by the need for the participating instructors to have a baseline of training experience in FLIP. Only instructors who have attended at least some formal FLIP training or had attended a seminar on FLIP were recruited for participation in the study.

Limitations

Due to the time constraints of the study itself, the study encompassed one semester in the spring of 2016. The study was limited by the available class sizes. While some large class sizes ($n > 45$) were desired for the study, none of the instructors utilized a FLIP model. Ultimately, only those classes that met the requirement of having instructors that utilized FLIP were used in the study. This study was limited to class sizes that were naturally occurring during the spring semesters of 2016. The study was only able to employ the services of two observers. Because only two observers were available for any one class observation time period, especially in a large class, several groups escaped analysis. This lessened the ability to generalize to other similar situations and even for drawing conclusions about the FLIP classrooms in this specific study.

Because of the lack of sample size, the study was limited in how much results could be generalized to other small-group active-learning situations outside of the context of the specific classrooms involved in the study.

The data collected were not a true random sample but were gathered from classrooms with professors who been trained to implement a FLIP or at least were very aware of the technique (in one case). No causal inferences could be made. Sweeping generalizations were not possible from the data and cannot be projected to other classrooms, but possible suggestions can be offered for strengthening the instructional design of a FLIP model.

Definition of Important Terms

Active Learning (AL): Active learning has, as its core, student activity and engagement. This is in contrast to the passive reception of information by students from the instructor in the traditional lecture (Prince, 2004). In order for active learning to take place students must, "read, write, discuss, or be engaged in solving problems … students must engage in such higher-order thinking tasks as analysis, synthesis, and evaluation … in doing things and thinking about what they are doing" (Bonwell & Eison, 1991).

Complexity Level of Overt Student Engagement (CLOSE): This is a measure of engagement that adapts the ICAP Framework to determine the complexity levels of overt engagement behaviors of students during small-group active-learning exercises (Chi & Wylie, 2014; Chi, 2011)

Flipped Learning Instructional Pedagogy (FLIP): For the purposes of this study FLIP means the viewing of videos and/or other materials by students before coming to class followed by in-class learning activities with very little lecture in the classroom. This is adopted from the definition of Bishop and Verleger (2013), “interactive group learning activities inside the classroom; and direct computer-based individual instruction outside the classroom” (Bishop & Verleger, 2013). A FLIP is any learning model where the majority of basic concepts of a course are off-loaded to be learned by students prior to coming to class. These are materials that in a traditional classroom would be given in a lecture format. The HOT concepts are then done in the classroom through AL. A general definition of FLIP allows for pre-class materials of any type of format, readings, video, podcasts, etc. A narrow definition, requires a pre-class video and/or podcast component and in-class AL through small-group activities and very short, if any, lectures.

Higher-Order Thinking (HOT): Higher-order thinking skills are critical-thinking skills. Higher-order thinking must include skills that are “relatively complex; require judgment, analysis, and synthesis; and are not applied in a rote or mechanical manner” (Halpern, 1998, p.451).

Summary

This chapter discussed the need for a study of student engagement patterns in small groups. A FLIP classroom provided a good context for such a study. A brief history of FLIP was included. The theoretical perspective of AL was

elucidated. Finally, four questions were presented that lead to an investigation of student engagement patterns in a FLIP classroom context. The following chapter will delve more deeply into the literature of student engagement studies and FLIP.

Chapter 2

Review of the Literature

This chapter is a review of overt student learning engagement patterns within the specific context of a FLIP. A FLIP provides a good context because the in-class portion of a FLIP purports to offer opportunities through student-centered active-learning exercises in small groups for student engagement in learning. There are, as a result several variables that must be reviewed both in and outside of a FLIP. This review will examine the literature of FLIP: its history, theory, definitions, types and research. Additionally, small group size, class size, AL and engagement will be reviewed as well as relevant studies pertaining to each. Definitions to both AL and engagement will be investigated along with research articles encompassing all of the above topics in relation to each other.

A Flipped Learning Instructional Pedagogy

A Flipped Learning Instructional Pedagogy (FLIP) is a pedagogy that “flips” the traditional instructional lecture and homework. Didactic course materials are moved to outside the classroom freeing up time in class for face to face active forms of learning, problem solving, discussion and homework (Jarvis, Halvorson, Sadeque, & Johnston, 2014; Moffett & Mill, 2014). A FLIP also “flips” the instructor-focus to that of student-centered learning (Saulnier, 2015). The in-class portion of a FLIP often makes use of small groups of students working together. The hope is that they will be actively engaged in cognitive learning

together in an interactive fashion to increase learning. The quantity of research on a FLIP has rapidly increased from nearly none in the year 2000 to an explosion of research and literature.

Definition of a FLIP. The definition of a FLIP can vary with each professor who employs the model. A consensus on a definition has been lacking but attempts are being made to come up with a common definition (Talbert, 2014b). With a restricted definition of FLIP, content normally covered by lecture in the traditional classroom is completed by the student before coming to class in the form of video lectures or other materials. Students take responsibility for pre-learning before coming to class often dealing with didactic lectures via videos provided online by the instructor (Berret, 2012; Hamdan, McKnight, McKnight, & Arfstrom, 2013; Tucker 2012). Practice exercises and problem solving are then done inside the classroom along with other AL exercises. Learning exercises can cover a range of strategies which promote active learning (Jarvis et al., 2014; Qiang, Cheng, Liu, & Yan, 2015; B. Tucker, 2012). Engaged, collaborative learning, solving challenging problems, and interactive group learning activities are stressed during the in-class portion of a FLIP (Berrett, 2012; Prober & Heath, 2012; Qiang et al., 2015; Tucker, 2012). With a restricted definition of FLIP, the traditional teaching lecture and homework are inverted (Lage et al., 2000a).

Bishop and Verleger (2013) point out that this is a simplistic version of what actually happens with a FLIP. More often than not the de-facto flipped classroom includes video lectures and closed-ended quizzes and practice exercises that

students do before coming to class. In the classroom, students implement group-based, open-ended problem solving along with questions and answers. This broader definition of FLIP means that students are more likely having an expanded curriculum in comparison to the traditional classroom. Videos are not necessary to a FLIP; basic content reviewed by students before coming to class can include readings and other items covering traditional lecture material. However, some have noted that students normally do not do readings (Bishop & Verleger, 2013). Bishop and Verleger (2013) provide a succinct definition of FLIP that is perhaps the narrowest or most restrictive,

> The flipped classroom is a new pedagogical method, which employs asynchronous video lectures and practice problems as homework, and active, group-based problem solving activities in the classroom. It represents a unique combination of learning theories once thought to be incompatible—active, problem-based learning activities founded upon a constructivist ideology and instructional lectures derived from direct instruction methods founded upon behaviorist principles.

Quiang, Cheng, Liu and Yan (2015) agree with this definition and restrict FLIP to only instances that use video prior to classroom activities, precluding broader definitions that assign readings only.

The lack of consensus on a definition as noted above points out the need for a common definition. An attempt at a common definition of a FLIP has been made by The Flipped Learning Network ("Definition of Flipped Learning," 2014; Talbert, 2014b). The Flipped Learning Network describes a FLIP in terms of learning, calling it Flipped Learning rather than a Flipped Classroom.

> Flipped Learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter.

History of FLIP. While most view the beginnings of interest by educators in the use of Flipped pedagogical approaches as the year 2000 (Baker, 2000; Bergmann & Sams, 2012; Lage et al., 2000a, 2000b; Morgan & Bergman, 2014; Saulnier, 2015) some point back to Mazur's work in physics at Harvard in the early 1990s as the starting point (Baggaley, 2015; Mazur, 1991; Moore, Gillett, & Steele, 2014). While Mazur worked with early iterations of the model with the advent of easy online access, the Internet, videos, youTube and Massive Open Online Courses (MOOCs), FLIP came of age (Bishop & Verleger, 2013). There is even a thinly disguised claim that FLIP is being fraudulently touted as a new pedagogy but is merely distance education in new clothing. This claim also states

that those involved may even be in it purely for finances and fame (Baggaley, 2015). Baggaley (2015) at least accuses several of not doing their research on the origins of FLIP. Whatever the true origins of FLIP may be the fact is that it is now a worldwide phenomenon. The widespread popularity of FLIP is depicted by a sampling of countries that currently utilize the pedagogy shown in Table 1.

Some classes such as law and language have used case studies during class for many years. In these classes, students would have to come prepared to class having done prior readings, or they would be totally lost during in-class case discussions. Classes heavy in discussion and case studies have long been employing a form of the flipped learning instructional pedagogy. Additionally, the work of Ausubel, by his emphasis on the importance of prior knowledge through advance organizers, could be viewed as an early use of a FLIP. In a controlled study, students were able to learn and retain meaningful verbal material by having introduction to concepts via advance organizers before coming to class. The advance organizers facilitated the incorporation and longevity of meaningful learning material over that of the control group. In essence, this was a form of early FLIP but without the inclusion of multimedia instructional materials. Describing the advance organizer, Ausubel (1963) states:

> these organizers are introduced in advance of the learning material itself, are formulated in terms that are already familiar to the learner, and are also presented at a higher level of

> abstractness, generality, and inclusiveness … this strategy simultaneously satisfies the substantive as well as the programming criteria already specified for enhancing the organizational strength of cognitive structure. (Ausubel, 1963, pp. 221–222)

Table 1. Countries utilizing a FLIP model.

Country	***Sources***
Australia	(Butt, 2014; Forsey, Low, & Glance, 2013)
Canada	(Deslauriers, Schelew, & Wieman, 2011; Galway, Corbett, Takaro, Tairyan, & Frank, 2014)
China	(Qiang et al., 2015)
England	(Moffett & Mill, 2014)
Iceland	(Frímannsdóttir, 2014)
India	(Prashar, 2015)
Ireland	(Ryan, 2013)
New Zealand	(Callum & Bay, 2013)
Norway	(Foldnes, 2016)
Puerto Rico	(Papadopoulos & Santiago-Román, 2010)
Scotland	(Bates & Galloway, 2012)
Singapore	(Mok, 2013; Teo, Tan, Yan, Teo, & Yeo, 2014)
South Africa	(Tanner & Scott, 2015)
Spain	(Albó, Hernández-Leo, Barceló, & Sanabira, 2015)
Taiwan	(Chen, Wang, Chen, Kinshuk, & Chen, 2014)
United States	(Bergmann & Sams, 2012; Fulton, 2012; Gannod et al., 2008; Kim et al., 2014; Lage et al., 2000b; Mason et al., 2013; Rossi, 2014; Sams & Bergmann, 2013; Talbert, 2012; Trogden, 2014)

The basic concept was for students to experience similar material before coming to class (Ausubel, 1960). The modern version of a FLIP centers on the use of multimedia before coming to class. Multimedia through podcasts and videos often embedded in a Learning Management System (LMS), a

Content Management System (CMS) or in web sites such as YouTube or Vimeo, became widely available starting around the year 2000. Viewing videos or listening to podcasts before coming to class is similar to students attaining some prior knowledge of the material through the use of advance organizers.

Theoretical perspective of FLIP. The flipped learning instructional pedagogy is based on the theory of active learning. The theory of engaged active learning (AL) presents the idea that AL leads to higher-order thinking (HOT) (Bonwell & Eison, 1991; Bonwell & Sutherland, 1996; Prince, 2004). If so, this is good for education and in contrast to the idea of students passively receiving information in traditional lecture types of formats (Bonwell & Sutherland, 1996). Bonwell and Sutherland (1996) note that students learn best when engaged in active learning and that this is not likely to occur in lecture. It is important that students are actively engaged in the learning process.

Bonwell and Sutherland (1996) developed a conceptual framework for instructors to use AL in their classes according to their styles of teaching and learning objectives of their courses. They promoted a wide variety of AL strategies that could be used in classrooms including cooperative learning and AL techniques. They note several barriers to active learning, including problems with content coverage and lack of materials. FLIP somewhat alleviates the barriers of content coverage (by off-loading them prior to class), and lack of materials (there are plenty on the Internet) (Bonwell & Sutherland, 1996). This off-loading is so important that McLaughlin et al. (2014) state, “We believe that

the actual practice of off-loading content and engaging in active learning in the classroom is far more important than the specific methods we used." They recently redesigned a large pharmaceutics class (*n* = 162) from a traditional lecture environment to a FLIP in order to foster learning and engagement (McLaughlin et al., 2014).

Again, a shared assumption of researchers in FLIP is that off-loading the content normally provided in lectures to pre-class activities will allow for more time to do activities in the classroom that cause students to think both deeply and richly, leading to HOT. These activities are often developed as collaborative group learning efforts (Bonwell & Sutherland, 1996; McLaughlin et al., 2014; Prince, 2004). The activities afford rapid feedback from both peers and instructors (Saulnier, 2015). Students are able to use newly acquired knowledge from the feedback for rapid correction of misconceptions. This can also help them to organize their new knowledge for future accessibility.

Interactions with peers and instructors during FLIP which are not likely to occur during traditional lecture can lead to new ideas being generated, or constructivism (Jarvis et al., 2014; Saulnier, 2015). Jarvis, Hlavorson, Sadeque, and Johnston (2014) place the theoretical underpinning for a FLIP firmly in the constructivist theories of learning. This theory states that people learn by interacting with others to create new knowledge. This knowledge both links to past knowledge or current knowledge and extend it further with the social interaction. This occurs during communication with others, and is challenged by

others to higher levels of learning. Scaffolding by teachers can help in the construction of new ideas, as can interaction with peers. When a FLIP supports constructive type activities, constructivism can be perceived as the basis of a FLIP (Jarvis et al., 2014)

There are many AL exercises that have been developed to aid in learning including teamwork, cooperative learning, debates, self-reflection, case studies, concept mapping, small-group presentations, peer teaching, and jigsaw, just to name a few (Bonwell & Sutherland, 1996; McLaughlin et al., 2014; Prince, 2004; Van Amburgh et al., 2007). Merely incorporating these exercises into the classroom will not guarantee student engagement in learning. The activities must be properly designed around learning outcomes. The activities must promote “thoughtful engagement” (Prince, 2004). If this is the case, AL will be increased in FLIP due to increased interactions and engagement with both students and instructors particularly when in small-groups (Bishop & Verleger, 2013).

While it is assumed that larger classrooms lead to less engaged AL, one might also assume that large classrooms broken up into smaller groupings can operate like small classrooms and, once again, lead to higher degrees of engaged AL (Bonwell & Eison, 1991; Bonwell & Sutherland, 1996). The basic theory then is that AL leads to HOT and FLIP provides affordances for that (Bormann, 2014).

Variations of FLIP. There is not a single correct way to implement a FLIP in a course. There is not one simple FLIP but rather many variations which often reflect instructors and their course objectives. A few of the more common types of a FLIP are the FIZZ model, the F-L-I-P™, FLIPPED, Flipped-Mastery and the Large Class Engagement Model (Bergmann & Sams, 2012; Chen et al., 2014; Hamdan, McKnight, McKnight, & Arfstrom, 2013; Jarvis et al., 2014; McCammon, 2013).

McCammon (2013) has taken the revised Bloom's Taxonomy and added a couple of layers that increase rigor in a FLIP, calling it the FIZZ method. He adds rigor to the revised Bloom's taxonomy level called creation as he has his students create products and then requires them to record and publish their creations. Above the creation level he adds teaching and reflecting. These are steps beyond the revised Bloom's Taxonomy. The reflection of student's specific recordings and published materials enables students to self-evaluate their creations and teaching (McCammon, 2013). McCammon's method of one-shot movie production is perhaps the easiest and quickest FLIP to implement (McCammon, 2013).

Hamdan, McKnight, McKnight, and Arfstrom (2013) have incorporated several key pillars of FLIP into the *F-L-I-P*™ variation. They emphasize flipped learning as opposed to a flipped classroom to emphasize the learning aspect. The idea is that the simple FLIP model without the proper stress on learning does not meet the goals of the model. Each pillar of their *F-L-I-P*™ variation represents a letter

in their variation. True flipped learning must provide: (a) Flexible environments; (b) a Learning culture that is student-centered; (c) Intentional content, and; (d) a Professional educator. These authors provide a checklist next to each element for the instructor to assess how well he is doing (Hamdan et al., 2013; Talbert, 2014b).

Chen, Chen, Wang, Kinshuk, and Chen (2014) believe that the *F-L-I-P*™ is not enough and can be improved. They created a *FLIPPED* variation by adding: (a) Progressive activities; (b) Engaging experiences, and; (c) Diversified platforms (Talbert, 2014b).

Bergmann and Sams (2012) both taught high school chemistry classes in Northern Colorado and basically stumbled upon a FLIP by making videos for students that were in need of special help. They have made the name Flipped Classroom a popular one (Bergmann & Sams, 2012). After many iterations of a FLIP, many successes and failures, and through trial and error they have arrived at their latest variation of a FLIP called *Flipped-Mastery*. This version of a FLIP allows students to watch videos at their own pace. Students move on to a new topic in chemistry once they have achieved a mastery level of 70%.

Jarvis, Halvorson, Sadeque, and Johnston (2014) place student engagement squarely at the center of their *Large Class Engagement Model*. In their FLIP for large classes they have student participation and involvement influencing engagement. This in turn, results in large-grained engagement outcomes such as

university and community involvement, loyalty and affective commitment. They view cognitive involvement of students to be a precursor to student engagement (Jarvis et al., 2014).

For many classes a FLIP is not used 100% of the time (Prashar, 2015). The extent of time a FLIP is used can vary. In a pilot study, Prashar (2015) determined three levels of flip. He based the level of a FLIP upon the context of modules and the extent of a FLIP required for each module session. He utilized a *Full Flip*, a *Partial Flip*, and a *Do Not Flip* depending upon this. A *Full Flip* session meant complete introduction to the concept online using lecture podcasts, online quizzes and readings. In a *Full Flip* session, emphasis was on building application, analysis, evaluation, and synthesis skills in the classroom while lower order skills were to be developed outside the class. A *Partial Flip* involved using a combination of online and face-to-face classroom instruction. This level is used for providing training on frameworks or models that need to be introduced in the classroom before their analysis and application are emphasized. The *Do Not Flip* level represented a traditional classroom teaching format with content-driven lectures (no subject matter was shared outside the classroom).

Research in FLIP.

Self-reporting research. Much of the research done on FLIP has been in the form of surveys and interviews that center around self-reporting perceptions of either students or instructors (Albó et al., 2015; Cynthia & Joseph, 2014;

Findlay-Thompson & Mombourquette, 2014; Forsey et al., 2013; Galway et al., 2014; McLaughlin et al., 2014; Tanner & Scott, 2015). Many of the studies have involved how students perceived or felt about a FLIP. Cynthia and Joseph (2014) discovered that students preferred to learn by doing rather than listening. Students in a systems analysis, design, and implementation course felt engaged during class exercises. FLIP had a positive impact on their attitude to learn, understand and to apply concepts. However, the students were reluctant to take charge of their own learning (Tanner & Scott, 2015).

Forsey, Low and Glance (2013) worked with a sociology class in Australia in which a FLIP was utilized. Students appreciated the flexibility, richness and productivity of a flipped classroom. Flexibility reduced travel time to classes. Students enjoyed the pre-class videos. The clear linear structure to the videos helped students be more productive. They enjoyed the clarity of structure, the shorter lectures, and the bite-sized pieces in the lecture videos. Even with some technical problems, students reported that they had more incentive to finish class than with traditional lecture courses. Albó, Hernández-Leo, Barceló, and Sanabira (2015) also reported increased flexibility, interactivity and autonomy with videos even though they were actually shown in a FLIP classroom. Though the videos were used in the class there were no lectures in this project based engineering course.

Galway, Corbett, Takaro, Tairyan, and Frank (2014) obtained self-report surveys from students in a higher education medical, environmental health and

occupation FLIP. In this graduate course students reported an increase in both knowledge and positivity towards learning. With a 100% response rate in a pre-post survey students were highly favorable toward a FLIP and wanted more of it showing strong preference for the model. They reported an increase in every competency. McLaughlin, et al. (2014) compared students in a large pharmaceutics class with a FLIP (*n*=162) to a traditional lecture class (*n*=153). A strong, statistically significant difference was found between the classes with a FLIP, with students showing greatly enhanced learning and engagement compared to the traditional class.

Post-term interviews of students by Finlay-Thompson and Mombourquette (2014) of a FLIP introductory business class and a traditional introductory business class resulted in mixed views of FLIP, identical final scores, heavier workloads for FLIP students but better feelings toward a FLIP.

Studies examining students self-reporting engagement in FLIP indicated significant increases in both quality and efficiency (94%) in an undergraduate information spreadsheet course (Davies, Dean, & Ball, 2013), 91.6% in an undergraduate history course (Murphree, 2014), 96% in an undergraduate statistics course (Wilson, 2013), 80% in a telecommunications undergraduate course (Willey & Gardner, 2013) and 100% in a graduate level law course (Lemmer, 2013). Again, one must be reminded that the above are all self-reporting either survey or interview types of studies.

Attitudinal and emotional studies. Many studies on FLIP have involved students' feelings or attitudes toward the model showing more (Findlay-Thompson & Mombourquette, 2014; Galway et al., 2014; Touchton, 2015; Trogden, 2014) or less satisfaction (DeSantis, Van Curen, Putsch, & Metzger, 2015; Prashar, 2015; Ryan, 2013; Strayer, 2012) with the model.

Learning outcomes. Some of the more recent studies have started to examine academic performance and learning outcomes in comparison studies. These studies are sometimes self-reporting and sometimes quasi-experimental. Studies have indicated either similar outcomes (DeSantis et al., 2015; Findlay-Thompson & Mombourquette, 2014; Galway et al., 2014; Margulieux, Bujak, McCracken, & Majerich, 2014; Margulieux, McCracken, & Catrambone, n.d.; Mason et al., 2013) between FLIP and traditional classes or better outcomes with a FLIP (Deslauriers et al., 2011; Mason et al., 2013; Papadopoulos & Santiago-Román, 2010) resulting in increased discussion (Herold et al., 2012), higher satisfaction (Papadopoulos & Santiago-Román, 2010; Whillier & Lystad, 2015), and higher final grades (Fulton, 2012; Rossi, 2014; Trogden, 2014). Students scored higher with a FLIP in courses that were more complex such as organic chemistry and statistics (Touchton, 2015; Trogden, 2014).

Summary of FLIP. A FLIP is a relatively new pedagogical idea in its current form. "Flipping" classrooms in language and law courses is not a new phenomenon. In these types of courses students have come to class having done necessary readings ahead of time with in-class discussions of cases and

language practice occurring during class (Bergmann & Sams, 2012). Flipped learning instructional pedagogies has become popular with the advent of the Internet and the ability to remotely and easily receive conceptual, basic class materials over YouTube, podcasts and other technologies. While used earliest in science disciplines in High School, FLIP has now become popular as a pedagogy in many other fields of learning. Flipped learning instructional pedagogy has spread to many disciplines and is now found in many countries at all levels of education. Table 2 demonstrates the widespread use of a FLIP across various disciplines.

Research on a FLIP initially consisted of behavioral and emotional surveys given to students measuring preferences for the model. Later studies have started to analyze academic performance as well. Very few studies have been attempted in a careful scientific manner and only one has been found that used randomization in a scientific manner. While AL and engagement have been analyzed in a FLIP to some degree the definitions of both differ greatly and sometimes become confused. A FLIP stresses small-group engagement through active-learning exercises during the in-class portion of FLIP. The following sections will examine literature on active learning, student engagement, and small-groups in the classroom.

Active Learning

Active learning as a concept is not new. The theory of engaged active learning (AL) presents the idea that AL leads to higher-order thinking (HOT) (Bonwell & Eison, 1991; Bonwell & Sutherland, 1996; Prince, 2004). It is very important that students' attention is retained by the instructor during learning (Mazur, 1991). Mazur (1991) points out that involving students actively in learning is a way to retain their attention and that asking questions is one way to help them be actively involved. A major difficulty exists though in differentiating between active learning and engaged learning (student engagement). Active learning, engagement, and time on task are at times interchanged, which can cause confusion when differentiating between engagement and active learning (Blatchford, Bassett, & Brown, 2011).

Definition of active learning. While there are slightly different definitions of active learning there are threads held in common by all. In order for active learning to take place students must be active and engaged in learning that is student-centered and not passive (Bonwell & Eison, 1991; Faust & Paulson, 1998; Mayer, 2004; Menekse et al., 2013; Watkins, Carnell, & Lodge, 2007) . Hands-on activities per se do not guarantee AL, students must be cognitively engaged (Mayer, 2004). As stated in chapter 1, AL has at its core, student activity and engagement. This is in contrast to the passive reception of information from the instructor by students in the traditional lecture (Prince, 2004). In order for active learning to take place students must, "read, write,

discuss, or be engaged in solving problems … students must engage in such higher-order thinking tasks as analysis, synthesis, and evaluation … in doing things and thinking about what they are doing" (Bonwell & Eison, 1991).

While there are common threads in active learning definitions, individuals stress certain distinctives. Sometimes higher-order thinking and group work are emphasized as in the following definition.

> Active learning engages students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. It emphasizes higher-order thinking and often involves group work. (Bonwell & Eison, 1991, p. iii)

A more constructivist approach is taken in this definition.

> Active learning refers broadly to innovative student-centered instructional approaches that dynamically involves students in the learning process. The main constructs of active learning are the participation and the engagement of students with concrete learning experiences, knowledge construction of students via meaningful learning activities, and some degree of student interaction during the process. *(Menekse et al., 2013, pp. 346–347)*

A concise definition is given below.

> Active learning is, in short, any learning activity engaged in by students in a classroom other than listening passively to an instructor's lecture. *(Faust & Paulson, 1998, p. 4)*

Watkins describes active learning as engaging one's energies amongst three parts: behavioral, cognitive, and social. Behavioral refers to "actively using and creating materials; cognitive to "actively thinking, constructing new meaning"; and social to "actively engaging with others as collaborators and resources" (Watkins et al., 2007, p. 71).

Mayer (1998) posits that,

> Hands-on learning is not necessarily the same thing as active learning. Instructional methods aimed at active learning seek to engage the learner's cognitive processes, such as helping the learner select relevant information, organize that information into a coherent representation, and integrate that representation with existing knowledge. Instructional methods that emphasize learning by doing can sometimes stimulate active learning, but may sometimes stimulate rote learning. The goal is not to provide behavioral activity per se, but rather to provoke productive kinds of cognitive activity. (p. 368)

In summary, active learning must not be passive, must be student-centered, must involve engaged, cognitive activity, should involve higher-order thinking,

Table 2. Disciplines that utilize a FLIP model.

Discipline	Sources
Accounting	Cynthia & Joseph, 2014
Actuarial Techniques	Butt, 2014
Agricultural Education	Conner, Stripling, Blythe, Roberts, & Stedman, 2014
Audiology	Berg et al., 2015
Business	Findlay-Thompson & Mombourquette, 2014
Chemistry	Rossi, 2014; Teo et al., 2014; Trogden, 2014
Computer Programming	(Mok, 2013; Tanner & Scott, 2015)
Engineering	(Albó et al., 2015; Gannod et al., 2008; Kim et al., 2014; Mason et al., 2013; Papadopoulos & Santiago-Román, 2010)
Epidemiology	(Moraros, Islam, Yu, Banow, & Schindelka, 2015)
Food Science	(Ryan, 2013)
Humanities	(Mok, 2013; Teo et al., 2014)
Introductory Economics	(Lage et al., 2000a)
Latin	(Harvey, 2014)
Law	(Matamoros, 2014)
Linear Algebra and Mathematics	(Foldnes, 2016; Mattis, 2014; Moore et al., 2014; Talbert, 2014a)
Materials science and engineering	(Demetry, 2010)
Military Education	(Chapnick, 2014)
Nursing	(Bristol, 2014)
Operations Management	(Prashar, 2015)
Pharmacology	(McLaughlin et al., 2013, 2014)
Physics	(Deslauriers et al., 2011)
Project Management	(Callum & Bay, 2013)
Public Health and Nursing	(Galway et al., 2014; Towle & Breda, 2014)
Sociology	(Forsey et al., 2013; Kim et al., 2014)
Statistics	(Foldnes, 2016; Papadopoulos & Santiago-Román, 2010; Strayer, 2007, 2012)
Veterinary Medicine	(Moffett & Mill, 2014)

Note: These studies represent a sample of FLIP studies from around the world.

and can involve construction of new knowledge with others. The need for active-learning, student-centered activities has stimulated educators into developing strategies to increase student engagement in active learning.

Active learning strategies. Active-learning strategies have been developed that can help induce students to become actively engaged in learning. Active-learning strategies must support rather than distract students. Many of these techniques have come from attempts to make the traditional lecture more engaging but can apply to a FLIP as well.

Suggested AL techniques include discussions, brainstorming, debating, write-pair-share, questioning, pause procedures, one-minute papers, the muddiest point, think-pair-share, case-based learning, concept maps, role-play, commitment activities, jigsaw, team-based learning, problem-based learning, thinking hats, brain dump/free write, formative quizzes/surveys, self/peer formative assessment, small-group presentations/discussions, games, categorizing grid, designing features matrix, peer teaching, cooperative cases, computer based interaction systems, student-generated questions, misconception/preconception check, application activity and simulation (Butt, 2014; Van Amburgh et al., 2007; Wolff et al., 2015; Yazedjian & Kolkhorst, 2007). These activities can provide both ways to interact socially and to push students from passive learning into active learning. However, overreliance on one method can become detrimental to learning (Yazedjian & Kolkhorst, 2007). While many of these strategies were adapted to the traditional lecture in order to break up

monotony and encourage more active learning, the techniques are being applied to a FLIP classroom as well (Van Amburgh et al., 2007; Wolff et al., 2015). Van Amburgh, Devlin, Kirwin, and Qualters (2007) have grouped the learning activities or strategies into low, medium and high levels of complexity.

Theoretical perspective of active learning. FLIP classrooms strongly rely on the theory of (AL). As defined in chapter one, AL has at its core student activity and engagement. This is in contrast to the passive reception of information from the instructor by students in the traditional lecture (Prince, 2004). Some associate constructivism closely with AL and indicate it leads to meaningful learning in opposition to the rote learning of the lecture (Hulshof, 2001). In order for AL to occur students must "read, write, discuss, or be engaged in solving problems … students must engage in such higher-order thinking tasks as analysis, synthesis, and evaluation … in doing things and thinking about what they are doing" (Bonwell & Eison, 1991). The theory of AL has been around for centuries in various forms. The theory of AL has been promoted by different persons at different periods in history under different names. Early proponents of AL were Rousseau and Pestalozzi. Most modern AL proponents draw upon the experiential learning theories of John Dewey including Kilpatrick, Piaget, Bruner, Wiggington, Freire and Sharan (Page, 1990).

Terms used interchangeably for AL are problem-based learning, discovery/inquiry learning, cognitive constructivism, social constructivism, cooperative learning, progressive education, collaborative learning, problem

solving and problem-based learning (Antepohl & Herzig, 1999; Mayer, 2004; Page, 1990; Prince, 2004). Page (1990) discovered four themes common to the primary proponents of discovery learning in her historical dissertation on AL. The themes were: “(a) rejection of the traditional teaching model; (b) an emphasis on the cognitive learning paradigm; (c) emphasis on the relationship between school and society; and (d) belief in the worth and ability of the student” (Page, 1990, p. 6).

The lecture method can be considered the traditional teaching method rejected by the AL proponents through time. Despite several centuries of up and down meanderings of discovery learning by leading proponents, Page (1990) questioned the breadth to which they had ever spread into the learning establishment as a whole. In an examination of three case studies over three decades Mayer (2004) concludes that “pure discovery” has not worked and can never work. Discovery must be guided carefully and appropriately scaffolded. He suggests that pure discovery has “struck out” and that AL or “discovery learning” can only work when cognitive activity is stressed over and above behavioral or hands-on activity. He suggests the best approach and “most genuine approach to constructivist learning is learning by thinking” (Mayer, 2004, p. 17).

In an examination of whether or not AL “works”, Prince (2004) found uneven support in engineering for the core elements of active, collaborative, cooperative and problem-based learning. It was found to be difficult to assess many relevant

learning outcomes at the same time. Problem-based AL was the most difficult activity to analyze for academic achievement but it improved student attitudes and study habits (Prince, 2004). A randomized experimental study compared problem-based AL to lecture-based learning in a basic pharmacology course. The study showed that there were no significant differences on final exams with the two groups. However, there was a tendency for students using AL to have slightly higher scores on the essay portion. The researchers concluded that the whole lecture-based course should be replaced by problem-based AL. This might be decided best with a cost-benefit analysis (Antepohl & Herzig, 1999). In pointing out the impact of constructivism on “discovery learning” or AL, Hulshof (2001) notes

> The importance that constructivism adheres to viewing learning as an active, instead of passive process, can be seen as analogous to Ausubel’s idea of meaningful learning. Meaningful learning is seen as more closely resembling the way learning takes place in the real world than rote learning. When coupled with the large advances in technology that have been made in recent years, the theoretical perspective of active learning can finally become fruitful.
>
> Adopting a constructivist point of view has an important implication for education. Because the process of

> knowledge acquisition is seen as an active, constructive process rather than a passive one, instruction has to aim at supporting and facilitating this constructive process, instead of relying on passive absorption of information. For instruction to assume this new role, it is necessary to create an atmosphere that evokes the processes …. (p. 14)

Perhaps small-group environments with a FLIP can provide the type of atmosphere that Hulshof indicates is necessary for discovery or active learning to occur.

Student Engagement

Definition of student engaged learning. There is not a great deal of agreement on a definition of engaged learning or student engagement in learning (Azevedo, 2015; Boekaerts, 2016; Christiansen & Salm, 2015; Sinatra, Heddy, & Lombardi, 2015). There is a much debate over the real definition of the construct of engagement. There is a problem differentiating between the precursors and outcomes of engagement and actual engagement. A recent review attempting to arrive at a general definition noted that what some call engagement is actually a precursor to engagement. Outcomes of engagement are also often confused with actual engagement (Kahu, 2011).

Student engagement can be viewed from either large-grained factors such as school attendance, school participation, community, sports involvement, or small-

grained factors such as overt engagement in learning activities (Chi & Wylie, 2014; Christiansen & Salm, 2015; Jarvis et al., 2014). The more common view of engagement is the coarse-grained view. If the boundaries of a definition become too coarse-grained or too fine-grained the resulting definition can lose the distinctiveness needed to separate it from other words. In other words, the term can become practically of little use (McDurmon, 2016). The 2015 Gallup Student Poll illustrates how broad a definition can become describing engagement as,

> The involvement in and enthusiasm for school. Engaged students are excited about what's happening at their school and what they're learning. These students contribute to the learning environment, and they are psychologically committed to their school. ("Gallup Student Poll Engaged Today — Ready For Tomorrow Fall 2015 Survey Results," 2016, p.3)

Christiansen and Salm (2015) examined fairly large-grained factors of engagement in a study of student engagement in an 8th grade health education course. Large-grained factors of student engagement include students' relationships with aspects of school, community, school structures, learning, curriculum, pedagogy, and opportunities to learn. The degree to which students are said to be engaged in learning depends on relationships to these large-grained factors. Just because students are participating and interactive does not mean they are actively engaged in learning if their participation and interaction

are not centered on learning content. If there is a low level of involvement with the subject material at hand, despite excitement or high participation, the student would be said to have very low cognitive engagement (Jarvis et al., 2014). Researchers have noted that student engagement should contain not a single concept but multiple factors. Student engagement should contain not a single concept but many dimensions such as social, behavioral, and emotional components (Christiansen & Salm, 2015).

While these are the main ingredients considered in many studies involving student engagement, some posit that social, emotional and behavioral engagement are mere precursors to actual overt student engagement in learning. Overt student engagement in learning is viewed as the component of utmost importance and is what should be measured, and that, at a very fine-grained observational level (Chi & Wylie, 2014; Chi, 2009; Chi, 2011; Menekse et al., 2013). This level would emphasize the physical and cognitive interaction with actual learning content as the primary factor in student engagement (Butt, 2014; Chi & Wylie, 2014; Menekse et al., 2013).

Some have described engaged student learning from a faculty perspective and from a pedagogical standpoint. From a faculty perspective, engagement involves students undertaking such activities as applying formulas, asking questions, doing research, being involved in hands-on activities, participating in discussions, presenting materials without notes, and reflecting on or working on problems. Students spend more time on a topic, are motivated to learn on their

own, ask questions in class, and pay attention. Students show engagement by participation in class discussions, by doing research projects, and by interaction with both faculty and peers.

From a student perspective, students may engage more due to particular components of a course such as discussions, projects, labs, or simulations. They may engage more due to a professor's teaching style, excitement or overall interest in the material. Their engagement may be a reflection of how much they can interact both with peers and with instructors. While faculty may view student engagement with outcomes in mind, students may see engagement more in terms of input of the instructor and of peers. They seek interaction, relevance, and experiential learning; all of these in turn may lead to engaged learning (Heller, Beil, Dam, & Haerum, 2010; McGlynn, 2008).

Types of student engagement. Three commonly described types of engagement are behavioral, cognitive, and emotional (Christiansen & Salm, 2015; Eryılmaz, 2015). A recent report lists the dominant research perspectives into engagement as behavioral, psychological, socio-cultural, and holistic (Kahu, 2011). Christiansen and Salm (2015) suggest that there are multiple dimensions of engagement that perhaps should be considered together: behavioral, emotional, and intellectual.

Behavioral engagement concentrates on teaching and includes positive conduct, adherence to class norms, involvement in learning and related learning

tasks, attending, concentrating, contributing, putting forth effort, and persisting, time on task, teaching, and social/academic integration (Christiansen & Salm, 2015; Kahu, 2011). It would also include school-related activities such as sports and clubs (Christiansen & Salm, 2015). Kahu (2011) includes large-grained institutional engagement measures: academic challenge, active learning, interactions, enriching education experiences, supportive learning, environment, work-integrated learning, higher thinking, general learning, outcomes, career readiness, grade, departure intention, and satisfaction. These activities do not necessarily lead to engagement in learning. Kahu (2011) concludes that there is much debate over the validity of these scales as engagement measures and states, “the reliance on surveys for measurement is a key limitation of the behavioural perspective” (Kahu, 2011, p. 760).

Emotional engagement concentrates on the individual and includes enthusiasm, optimism, curiosity, interest, and affective reactions to learning and school that, once again, may not lead to actual learning (Christiansen & Salm, 2015; Kahu, 2011). Emotional engagement can include large-grained measures such as school attachment, bonding and connection. Kahu (2011) labels emotional engagement as psychological and breaks it into the dimensions of behavior, cognition, affective, and conation. Behavior dimension measures may include attendance, involvement, time on task, asking question, participation in extracurricular activities, and sense of belonging (Kahu, 2011). The cognitive dimension of engagement is focused on learning, investment in learning,

understanding, intellectual engagement, and self-regulation. Illustrations of the cognitive dimension includes positive coping, enjoying challenge, performance goals on focused learning, mastering a task (Christiansen & Salm, 2015; Kahu, 2011).

Christiansen and Salm (2015) discovered four themes that emerged from their study on student engagement of 8th graders in health education. These were behaviors and emotions: enjoyable learning, purposeful learning, planning for student voice and choice and planning supportive learning environments. Students engaged in topics that were interesting to them. Students wanted relevant learning. When topics were relevant to them their interest in learning was increased and engagement increased. The affective dimension of emotional engagement includes attachment, belonging, enjoyment and interest. The conation dimension uses measures having to do with the will. These include the will to succeed, belief, courage, energy, commitment, conviction, and change. It can be seen that these dimensions can cause inconsistent measures of engagement and confusion over definition as they bleed into each other (Kahu, 2011). Finally, Kahu (2011) notes socio-cultural engagement factors. These look at the broader social context: why students lose engagement, alienation, and institutional culture.

Because of the complexity of types of engagement and dimensions found within some of these types, a holistic model has been proposed. The holistic engagement model is viewed as a dynamic continuum not measurable by

surveys but through in-depth qualitative work. Engagement studies need to differentiate between engagement precursors and outcomes in order to arrive at actual student engagement in learning. The state of students being engaged is of prime interest. This engagement can be subdivided into affective (enthusiasm, interest, belonging), cognition (deep learning, self-regulation), and behavior (time and effort, interaction, participation). However, it should not be confounded with precursors or products of engagement (Kahu, 2011).

Research on engaged learning in FLIP. Not all research on engaged learning in FLIP has been positive (Lavelle, Stimpson, & Brill, 2015) . Lavelle, Stimpson, and Brill (2015) conducted research examining five semesters of a FLIP engineering economy course starting in the fall of 2012. Through several course FLIP iterations, one finding was a constant. Students expressed in their surveys that they were not more engaged with materials and that they did not like a FLIP approach better than a traditional lecture format. Approximately 70% of the surveyed students did not prefer FLIP; 65-90% disagreed they were more engaged with the materials in a FLIP classroom (Lavelle et al., 2015).

Tools for measurement of classroom engagement. Most tools developed to measure engagement in the classroom to this point have been for use in the traditional lecture pedagogy and with the viewpoint of the instructor at hand. There is a recent tool that departs from this pattern (Lane & Harris, 2015). Lane and Harris (2015) have created Behavioral Engagement Related to Instruction (BERI) protocol, “the first systematic classroom observation instrument for large

university classes that provides quantitative data identifying student behavioral engagement". This tool was designed to: (a) quantify student behavioral engagement, and; (b) determine how student behavioral engagement varies with classroom activities, instructional methods, and between instructors. Students that are categorized using this tool are rapidly assessed as to being either engaged or disengaged. The information is then provided as feedback to instructors immediately after class. This information provides timely, formative feedback in graphical form that can be easily related to the pedagogy and curricular content of the lecture. This feedback can help instructors improve engagement in their teaching (Lane & Harris, 2015).

Summary

This literature review has examined FLIP definitions, history, and research as well as definitions of active learning, and student engagement. The modern history of FLIP is relatively short. The popularity of FLIP has rapidly increased as easy access to remote videos has occurred with the advent of the Internet. Accompanying this increase has been a rapid rise in research on FLIP though it has primarily focused on self-reporting surveys and interviews. There has been recent interest in academic performance with FLIP. No fine-grained engagement studies have been done that focused on small-group engagement patterns in student-centered active-learning exercises.

Definitions for FLIP, AL, and student engagement are loaded with uncertainties and ambiguities. Attempts to arrive at standard definitions with

each of the terms are ongoing. Research in class size and effects of specific learning activities on student engagement is lacking. Small-grained examination of student overt behavioral engagement in FLIP is, at present, non-existent. The lack of literature about these variables illustrated the need for this study. The proposed methodology used for examining the issues described in the research questions from Chapter 1 is described in detail in Chapter 3.

Chapter 3

Materials and Methods

The primary purpose of this study was to examine student engagement patterns and behaviors during active-learning exercises within small-groups, in higher education courses that utilized a flipped learning instructional pedagogy (FLIP). In order to do this it was necessary to focus on the variables of small-group size, student overt behavioral engagement in learning activities, and on the specific activities designed for that learning. This entailed: an examination of the complexity of engaged behaviors within different types of student-centered active-learning exercises (SCALE), and an examination of the relationship between instructors' estimates of student engaged behavior and actual observations of students' classroom behavior in the SCALE. This chapter addresses the materials and methods used to accomplish these aims. The chapter starts with a restating of the questions; the rationale behind the research questions and ends with a description of the research method and data collection process. The chapter discusses research setting and selection of participants, the research design, observation tools, research hypotheses, statistical hypotheses and data analyses.

Observation Tool Development

Analysis of the primary question was explored with a revision of the *Active Learning Inventory Tool* © 2006 in combination with the Interactive, Constructive, Active, Passive Framework (*ICAP Framework)* as shown in Appendices A and B

(Chi & Wylie, 2014; Van Amburgh et al., 2007). Using an observational checklist formed by a combination and revision of these two instruments, student behaviors during small-group activities were observed, timed, categorized and rated for degree of complexity. The *Active Learning Inventory Tool* © 2006 is a valid and reliable tool specifically developed to document the type, amount, complexity and length of active learning occurring in college classes that use the traditional lecture pedagogy. In these lecture classes AL events were initiated by instructors. Student engagement was not a measure within the activity list associated with the original tool (Van Amburgh et al., 2007). Van Amburgh et al. (2007) developed this inventory list by observation of AL exercises used in traditional lecture formats. The *Active Learning Inventory Tool* © 2006 was developed by researchers working with instructors and teaching assistants to define the best active-learning practices to promote AL in a lecture setting. The active-learning exercises presented in the tool are designed to encourage AL and have been assigned levels of complexity as active-learning strategies. However, the *Active Learning Inventory Tool* © 2006 inventory was not designed to measure complexity levels of overt student engagement during the active-learning exercises. Because the *Active Learning Inventory Tool* © 2006 was developed by instructors and teaching assistants specifically to address active-learning in lecture situations, unforeseen group activities had to be added for this study that were not in the inventory. These active-learning exercises include

items like text analysis, ponderables, and grammar worksheet and appear with other SCALE items shown in Appendix C.

For this study, the *ICAP Framework* was combined with the *Active Learning Inventory Tool* © 2006 in order to create a new tool to record the complexity of engagement by students in the student-centered active-learning exercises (Chi & Wylie, 2014; Chi, 2011; Van Amburgh et al., 2007).

The *ICAP Framework* allows for a much finer-grained observation of overt student engagement in learning activities than other available tools. The *ICAP Framework* was used to measure the Complexity Level of Overt Student Engagement (CLOSE) for each student during each active-learning exercise in the small groups. The complexity levels were determined by applying the *ICAP Framework* descriptions of overt engagement behaviors noted by the observer during the active learning observed in small-groups. The time duration, type, and level of active-learning exercise were measured using the behavioral descriptions from the *Active Learning Inventory Tool* © 2006. The complexity levels of overt student engagement (CLOSE) during these exercises were measured using the behavioral descriptions from the *ICAP Framework* shown in Appendix D. These behavioral descriptions were used in combination with activities from the *Active Learning Inventory Tool* © 2006 with any new activities described by the instructors and shown in Appendix C. The CLOSE SCALE tool shown in Appendix E was used to record these measures of student engagement in the small groups during learning activities.

Lastly, instructors' estimated the degree students engaged in AL in their classrooms. This information was gathered from the instructors or teaching assistants with assessments at the end of each observed class period. Instructors or teaching assistants were asked to give their estimates of student activity levels in the active-learning exercises (SCALE). Each instructor gave a numerical estimate of student engagement for the whole class as well as for the particular groups under observation. The estimated range was from 0 to 4 with 0 representing off-task and 4, highly engaged or highly active students. The instructor's estimate for individual observed groups was compared to the complexity moment calculated from the CLOSE SCALE observation tool to record the engagement behaviors of a single small group. When two observers were present the estimate for the class as a whole was compared to the average of the complexity moment score calculated from the CLOSE SCALE observation checklist used to record the engagement behaviors of a single small group.

Calculation of the complexity moment. The complexity moment is a calculation for a single group during one group activity. An example of the calculation of the complexity moment is found in Figure 1 which illustrates the CLOSE section of the developed CLOSE SCALE observation tool. This score is a single number value that represents the complexity of student engagement of that particular group in the activity. The complexity moment score is a weighted score that takes into account the respective complexity values in the *ICAP Framework* assigning greater value to the higher levels. The CLOSE tally sheet

for this examples shows that there were two males and two females in the observation, a mixed group. The complexity moment calculated for this particular activity was 2.5. In this example, males were engaged at higher levels than the females; they were engaged at higher ICAP categories than were the females. The complexity moment for the group as a whole was midway between two and three. This placed the engagement level between “constructive” and “active” based upon their respective numerical values. Each tally represents one minute of time for a student. Student one, for example, arrived at an “interactive” engagement point at some point in a one minute span and arrived at a “constructive” engagement point in a different observation minute. Initially, it was thought that a majority of a time interval needed to be spent at a specific complexity level but from day one the reality of the classroom made that approach nonsensical. The various levels simply do not last that long in classroom settings and it was deemed necessary to record student engagement levels according to the highest level reached during the interval.

The *ICAP Framework* is a framework designed to identify engagement complexity. In the CLOSE portion of the CLOSE SCALE tool the first letter of each engagement level represents that level of engagement spelling ICAP. Each letter was assigned a number value that represents the relative strength of that engagement behavior. The off-task column was assigned a numerical value of 0 and is not considered as engagement but rather, non-engagement. The columns from left to right are interactive, constructive, active, passive, and off-task with

		Complexity Level of Overt Student Engagement (CLOSE)*					
		On-Task				Off-Task	
Student	Sex	4 - Interactive	3 - Constructive	2 - Active	1 - Passive	0 - Off-Task	Notes on engagement
1	M F	I	I				
2	M F		I		I		
3	M F	I				I	
4	M F			II			
5	M F						
6	M F						
7	M F						
8	M F						
9	M F						
10	M F						
11	M F						
12	M F						
Total	2|2 = 4	2	2	2	1	1	= 8 min.
Weighted Score**		2 X 4 = 8	2 X 3 = 6	2 X 2 = 4	1 X 1 = 1	1 X 0 = 0	19/8 = 2.5

The complexity moment is calculated by adding the weighted scores and dividing those scores by the total minutes in the activity

*A tally signifies the highest level of engagement reached during a one minute observation interval.
**A weighted score is determined multiplying the sum of each column by its assigned number value.

Figure 1. Complexity moment calculation.

assigned values (category weights) of 4, 3, 2, 1, and 0. The complexity moment calculated number that enables a person to rapidly assess the overall engagement level of a group in a particular active-learning exercise. The maximum complexity moment 4. This value indicates that all students achieved an interactive level of complexity for a portion of every minute they were observed. A 0 indicates that students were off-task every minute that particular group was in the exercise. While all four of the ICAP levels were evaluated based upon a student reaching the highest level during a minute of observation, off-task was measured as being completely off-task for the minute.

In summary, the complexity moment is calculated by using the CLOSE section of the CLOSE SCALE instrument. The first step in calculating the

complexity moment score is to sum all tallies in the interactive column; a tally mark represents the highest achieved engagement complexity level during the observation minute. The next step is to sum the tallies in the other columns in like manner. The third step is to multiply each column summation by the category weight assigned for that particular column to arrive at a weighted score. The fourth step is to sum all of the multiplied category weight scores into one weighted sum, the activity RAW score. In the final step, the activity RAW score is divided by the total number of tallies, a number equal to the total time during which the observations were made, the total time spent by the students in completing the activity. This final division results in the complexity moment for the particular observed activity.

Research Questions and Rationale

This section provides rationale for the research questions stated in chapter 1. In each case the research question is restated followed by an associated rationale. Each question is framed within the context of a FLIP model and small group sizes of two or greater.

Research question 1. What proportion of total class time in a FLIP classroom is typically spent in student-centered active-learning exercises (SCALE)?

Very little in the literature indicates the proportion of time students spend in engaged learning during AL exercises. A review of the literature suggests that

time spent in student-centered active-learning should be greater in a FLIP classroom than with the traditional lecture. This may or may not be true in all cases with FLIP depending upon a number of factors: intended instructional design, seating arrangements, room architecture, type of active-learning exercises, student-instructor interactions, and the number of small groups used. The length and variety of active-learning episodes in lecture settings are minimal until instructors break students up into smaller groups (Van Amburgh et al., 2007). Both types and duration of AL exercises are expected to be more numerous and of longer duration in FLIP classrooms than in traditional classrooms due to the collaborative nature of a FLIP. Results for research question one provide insight into the proportion of total time being spent in active-learning exercises in FLIP classrooms.

Research question 2. Will students who participate in instructional activities classified at different levels of difficulty (as classified by the SCALE instrument) perform differently in terms of amount of time spent at different levels of overt student engagement as measured by the CLOSE instrument?

The *ICAP Framework* allowed for a close examination of complexity levels of overt student engagement during their learning activities. This question determined if students who participated in instructional activities classified at different levels of difficulty as classified by the SCALE instrument would perform differently in terms of amount of time spent at different levels of overt student engagement as measured by the CLOSE instrument.

Research question 3. Will students in different sizes of small groups perform differently in terms of amount of time spent at different levels of overt student engagement as measured by the CLOSE instrument?

It is generally implied in the literature that small collaborative groups promote overt, engaged behaviors in AL exercises. This has not been demonstrated through fine-grained observations in the classroom setting. Various active-learning exercise strategies implemented during lectures have been examined in prior studies. Instructor-student interactions have also been observed in studies. Most often these observations are in larger classrooms. These observations have generally been from the viewpoint of the instructor and not from the point of view of the student and normally in a lecture context. No attempts have been made to measure student engagement through observations of their overt behaviors during active-learning exercises in a FLIP classroom (Chi & Wylie, 2014; Van Amburgh et al., 2007; West, Paul, Webb, & Potter, 2013). Further, there has been no examination of any relationship between size of group and complexity level of students' engagement during student-centered active-learning exercises.

Research question 4. How do instructor estimates of whole class student engagement during small-group activities correlate with student engagement as measured by the CLOSE instrument (complexity moment)?

Instructors' estimates of the proportion of time students spend in complexity

levels of student engagement during student-centered active-learning exercises could be on target or could vary from the actual observed values. The estimates the instructors gave were subjective estimates. Their perception of student engagement was based upon whole class observation. The subjective whole class estimates of the instructors were compared to the objective complexity moment scores measured from the CLOSE SCALE instrument. CLOSE SCALE complexity moments are objective measures of engaged student behaviors in the small groups rather than in the complete class. Instructors were asked to give a numerical estimate from zero to four of student engagement with zero being off-task, and four being highly engaged. If instructors' estimates were closely correlated with the complexity moments, they could feel fairly confident in the accuracy of their perceptions. If higher-order thinking is a desired goal and an instructor's perceptions closely correlate with complexity moments, adjusting activities to higher complexity levels can help students reach this goal.

Research Design

To answer the research questions in this study required careful observations by trained observers using the newly designed CLOSE SCALE checklist shown in Appendix E. Question 1 was determined by summing the total time students were in small-group activities for a particular class period and dividing that number by the length of the class period.

Results for questions 2 to 4 were analyzed to discover the statistical

significance for the variables in the questions. Alpha for all statistical analyses was set at .05. Results for question 2 were analyzed to test whether proportions of time students spent at different levels of engagement differed according to the difficulty of the SCALE activity. A χ^2 test of independence analysis was used to determine the proportional relationship between the variables of activity level according to SCALE and complexity level of overt student exercises. Question 3 results were analyzed with a χ^2 test of independence in similar fashion to Question 2. Question 4 results were analyzed by correlating the instructor's estimate of activity of the whole class in SCALE activities on the average complexity moments from both observers calculated from the CLOSE portion of the CLOSE SCALE tool.

Additionally, a correlation was calculated based upon the instructor's estimate of activity of observed groups on the complexity moment calculated from the CLOSE portion of the CLOSE SCALE tool. This was added to determine how well an instructor could estimate the engagement of students in the specific small groups rated by the observers. For this question instructors gave their estimates, from 0 to 4, of their perception of complexity of student engagement for each activity. The instructor was informed that 0 represented off-task behaviors and 4 represented strong interactions among students. Two small groups were examined for each class observation; one per evaluator. Whenever two observers were present, two small-group estimates were provided by the instructor. The primary observer was always available to observe. Whenever it

was possible to do so, two observers were used but at times the observers had to split up and observer separate courses that met at the same time period.

If on that particular day two activities were done, four estimates were provided for the small groups and two for the overall class during those group activities. Complexity moments were calculated for all observed groups and for each activity. Instructor estimates were compared to the complexity moments to determine correlation values. More information about specific observers, observation frequencies and courses is found in Chapter 4 in the small-group observation section.

Research Hypotheses, Statistical Hypotheses, and Data Analyses

This section provides the research hypothesis for each question followed by the statistical hypothesis and the data analysis. The statistical hypotheses are written using the following acronyms:

CLOSE – Complexity Level of Student Engagement, **SGS –** Small-group Size, H_0 **–** Null Hypothesis, H_1 **–** Alternative Hypothesis, **IE –** Instructor Estimate, **SCALE –** Student-centered Active-learning Exercise

Research question 1. What proportion of total class time in a FLIP classroom is typically spent in student-centered active-learning exercises (SCALE)?

Data Analysis

Simple proportions of time spent in small-group learning activities were

compared to total class time for each course. The mean proportion of time spent in small-group learning activities compared to total class time was determined as an aggregate and for individual courses.

Research question 2. Will students who participate in instructional activities classified at different levels of difficulty as classified by the SCALE instrument perform differently in terms of amount of time spent at different levels of overt student engagement as measured by the CLOSE instrument?

Research Hypothesis

Students who participate in instructional activities classified at different levels of difficulty as classified by the SCALE instrument will perform differently in terms of amount of time spent at different levels of overt student engagement as measured by the CLOSE instrument.

Statistical Hypotheses

H_0: $\chi^2 = 0$

H_1: $\chi^2 > 0$

Data Analysis

A Chi-square statistic was calculated based upon the proportion of time students were in student-centered active-learning exercises tallied from the CLOSE portion of the observation checklist. The proportion of time was compared for each degree of difficulty of SCALE activity: low, moderate, or high.

Research question 3. Will students in different sizes of small groups perform differently in terms of amount of time spent at different levels of overt student engagement as measured by the CLOSE instrument?

Research Hypothesis

Students who participate in instructional activities in different sizes of small groups will perform differently in terms of amount of time spent at different levels of overt student engagement as measured by the CLOSE instrument.

Statistical Hypotheses

H_0: $\chi^2 = 0$

H_1: $\chi^2 > 0$

Data Analysis

A Chi-square statistic was calculated based upon the proportion of time students were in student-centered active-learning exercises tallied from the CLOSE portion of the observation checklist. The proportion of time students spent in each engagement level was compared to the size of the group of students in each activity.

Research question 4. How do instructor estimates of whole class student engagement during small-group activities correlate with student engagement as measured by the CLOSE Instrument (complexity moment)?

Research Hypothesis

Instructor estimates of whole class student engagement during small-group

activities will correlate with student engagement as measured by the CLOSE instrument (complexity moment).

Statistical Hypotheses

H_0: $r_{xy} = 0$ [x = **IE**, y = **CLOSE**]

H_1: $r_{xy} \neq 0$ [x = **IE**, y = **CLOSE**]

Data Analysis

A Pearson product-moment correlation coefficient was calculated using instructor estimates of whole class student engagement and estimates of the specific small groups observed by the raters. The whole class estimates were correlated on the average of complexity moments of both observers on activities for a specific day. The estimates for specific small groups were correlated on the calculated complexity moment for those specific groups.

General Analyses Notes

The software application, International Business Machines Corp., Statistical Package for the Social Sciences, IBM® SPSS® Statistics version 23 (Copyright © 1989, 2015 IBM Corporation and its licensors), was used to conduct analyses on Inter-observer Reliability (IOR) and for correlations on instructor's estimates of student engagement levels during activities. The software application, JMP® Pro 12.0.1 (32-bit) (Copyright © 2015 SAS Institute Inc. All Rights Reserved), was used for χ^2 testing and to help with sorting of data. Microsoft® Excel 2013 Professional Plus was used for general calculations and for sorting of data.

Inter-rater reliability. Raters discussed in detail the overt student engagement behaviors that were to be examined in order to determine the modes of student engagement which are shown in Appendix D. These overt behaviors enabled the raters to determine which category of engagement should be selected and marked with a tally mark in the CLOSE SCALE instrument over the course of a single minute of observation. Once these behaviors were noted and carefully discussed, the raters practiced coding through observation of classes of various age groups in online YouTube videos and a comparison of CLOSE SCALE coding results. After the practice sessions the raters discussed differences and similarities in coding in order to fine tune their observational skills.

Inter-rater reliability (IRR) was pilot tested at this point (pre-semester). The CLOSE SCALE tool was used to rate engagement modes of students in five different classroom activities on YouTube. Each rater individually rated these activities and classrooms through utilization of the CLOSE SCALE tool. The observed classroom activities included discussion, peer teaching and debate and were rated at the moderate SCALE level. Both raters observed the same groups, and tallied results were compared for reliability. Reliability tests were calculated using the IBM®SPSS® Statistics Version 23 software package.

Inter-rater reliability (IRR) was tested in early observations in the classrooms. The two raters rated the same groups during early semester and mid-semester observational periods. Because reliability was above .70, the investigators were

able to go back to observing separate groups. Results for IRR are shown below in Chapter 4.

Observational Classroom Setting

Classes using a FLIP at the University of Tennessee at Knoxville (UTK) campus were observed in the Spring Semester of 2016. Individual classroom characteristics differed based upon the instructors' classroom arrangements, classroom sizes, course descriptions and SCALE complexity levels. The characteristics of each class were noted and comparisons were made between the different classes. Classes were selected that utilized small-group exercises during the semester. A range of class sizes was sought from small ($n \leq 25$) to large ($n \geq 75$) and 8 were selected that ranged in size from 9 students to 45 students. Classroom layouts and seating arrangements were noted or drawn for each class before small groups were observed. If groups changed during class, these changes were noted with classroom sketches in the notes section of the CLOSE portion of the observation tool. Seating and group arrangements changed both throughout the semester and within class periods; small-group learning models typically require flexibility.

Participant Selection and Description

Eight courses were selected from the overall student body at the University of Tennessee with class sizes of 9 to 42, depending upon subject availability, during the spring semester 2016. The participants were chosen through a purposeful

sampling procedure based upon the recommendations of the Tennessee Teaching and Learning Center at UTK and upon informal conversations with other professors who knew instructors that were using a FLIP approach to teaching. Emails were sent to potential course instructors in order to find those willing to be involved in the case study. The mail explained the basic goals and nature of the study along with the needed characteristics of a FLIP classroom.

In order to be included in the study, FLIP instructors needed to utilize small-group activities during in-class settings. When the desired sample size was not obtained follow-up phone calls and emails were made within a week. The initial goal was to find six faculty members who had some FLIP training in the Summer Institute held annually at UTK. This was in order to establish a similar baseline of knowledge in FLIP by instructors to reduce potential confounding of data. Instructors were chosen that utilized at least a partial FLIP model in their classrooms in the spring semester of 2016. It was also necessary that these instructors use small-group activities in their classrooms.

Faculty members initially met with the investigator prior to classroom observations. A pre-observation interview was conducted at this meeting. Information was gathered to establish basic background information about each class for characterization purposes. Before the interview and upon mutual agreement to the study, each instructor was asked to sign an Institutional Review Board (IRB) informed consent agreement. Though initial plans were to sample classroom populations over three different periods of time during the semester,

early, mid- and late- term, this plan was amended due to the constraints time, to include only early and mid-term observations. Instructors were interviewed a second time after all observations were completed. A table of the observations will be included in the findings section in Chapter 4.

Human Subjects Consideration

The researcher conducted interviews with the instructors before initial classroom observations began. Basic details of the research were discussed with the instructors before research began along with an explanation of IRB requirements. Faculty interested in contributing to the research indicated their willingness to be involved in the research study by completing consent forms. Faculty were informed that they could voluntarily withdraw from the study at any time, without repercussions. The researcher greeted interested faculty and provided them E-mail that conveyed the importance, purpose, and overview of the procedures involved with this study. Students in the study were all at least second semester freshmen and above, with most students in the upper levels. All subjects, both students and instructors, were made aware of the observational research and were allowed to opt out of any observations. While the researcher and the second rater were close to the students in their groups, interactions with the students were kept to a bare minimum in order to: (a) not disturb the students, and; (b) to not bias the research. It was necessary to stay close enough to the students to catch the nuances both in voice and action in order to detect the various complexity levels of engagement. Lessons were not interfered

with in any way to the detriment of the student sample population, and all observations were conducted as unobtrusively as possible. If a student chose to opt out a way was provided between the observers and the instructor to accommodate the student's desire and the grades would not be affected. Informed consent forms were distributed by the researcher and signed by students. Students were informed that they would be provided a copy upon request. All copies are stored in a secure location per IRB requirements. Before any observations were conducted and any informed consent forms were signed, students were give a verbal description of the observation protocol by the investigator.

Clearance from IRB

Before the start of this study, approval was obtained from the University of Tennessee Institutional Review Board (IRB). Appendix F shows the Institutional Review Board clearance letter. Copies of both the instructor and student consent forms are found in Appendix G.

Description of Observation Tools and Development

The CLOSE SCALE tool was utilized for observation in this study. This tool is a modification of the *Active Learning Inventory Tool © 2006* and the *ICAP Framework* (Chi & Wylie, 2014; Chi, 2011; Van Amburgh et al., 2007). The *Active Learning Inventory Tool © 2006* shown in Appendix A was revised to adapt it for small-group situations. The *Active Learning Inventory Tool © 2006*

was designed as a tool to measure small-group activities in lecture settings. This tool includes whole class student-centered active-learning exercises and is not strictly centered on small-group activities. Several of the low complexity activities such as the one-minute paper, question and answer, and muddiest point do not commonly occur in small-group activities. Other activities in the inventory tool were added as instructors thought of activities more suited for their particular small-group situations. For these particular activities both a description and complexity level were elicited from the instructors. The added activities are shown in Appendix C.

The *ICAP Framework* was modified to form the CLOSE portion of the CLOSE SCALE tool. Furthermore, the purpose of the *ICAP Framework* is to examine fine-grained engagement levels within the student-centered active-learning exercises (SCALE). A sample of the *ICAP Framework* can be viewed in Appendix B. This framework describes the four modes of engagement derived from specific overt behaviors. The framework is rated for complexity level from the greatest to the least, from interactive engagement to passive engagement. The particular portion of the *ICAP Framework* in focus for the purposes of this study were the taxonomy of 4 modes, their definitions, the hypothesis, and learning activities by mode of engagement. In particular, the learning activities by mode of engagement were memorized by the observer team. Memorization of the modes of engagement was necessary so raters could make rapid decisions in classifying the complexity of student engagement in overt student learning

behaviors during classroom observations. A final edition of the instrument (checklist), a combination of the *ICAP Framework* with the *Active Learning Inventory Tool © 2006*, the CLOSE SCALE checklist, is found in Appendix E.

Research Method

This study was an observational quantitative case study. However, it also included certain qualitative aspects in order to characterize the instructors and their classrooms. The study was observational in nature. Observers acted as non-participants as they rated student behaviors in the natural setting of the classroom. It was qualitative in that the natural unfolding of the class was unknown from the start and various adjustments were made to the CLOSE SCALE instrument. It was quantitative in that behaviors were timed and complexities of engagement per unit of time were tallied for statistical analyses. Detailed descriptions of pre-class activities and classroom settings were noted through interviews and observations.

A qualitative aspect of this investigation was the rapid, subjective decision making during judgments of complexity levels of CLOSE, as possible new behaviors were revealed. The quantitative aspect was the process of making engagement “counts” and behavioral assignments to SCALE within each observation event. There was a quantitative aspect to this study in that engaged AL behaviors were categorized and timed by the observers. The approaches

were implemented in line with the goals of the study, the research setting, and a FLIP pedagogy employed.

The classroom is the normal natural setting for engaged AL behaviors for FLIP (Creswell, 2008). Interviews were conducted to establish the faculty members' backgrounds and experiences with FLIP before the study and after the last observations to determine their estimates of engagement levels of AL behaviors in the classroom and other general information.

Data Collection Process

Data collection started with pre-observational interviews and ended with post-observational interviews of the instructors. However, the major portion of the research was observation of the students' engagement levels in their small-group activities in the classroom. The proposed minimum number of expected observations was 30 in six classes. The actual observation number was 60 in eight classes. The two observers rated the same groups early in the observational period and towards the end in order to establish strong inter-rater reliability under classroom conditions. Inter-rater reliability was high during the complete study. For most of the study the observers rated separate small groups. The results from inter-rater reliability are in a table in Chapter 4 findings.

Instructor data. After instructors signed their consent forms, they received a pre-observation interview. This was a fairly informal time to get acquainted with each other, with the observation process, and to determine background information about the instructor's teaching experiences regarding a FLIP model,

and specifically about the description of prior learning activities required of the students during the semester. Appendix H shows a list of questions that were asked of each faculty member. The characterization of the pre-class portion of FLIP included questions on types of materials required, potential quizzes, and the general make-up of the pre-class portion of FLIP. Information about the amount and number of small-group breakouts in a normal FLIP class was gathered. Calendar and syllabus information for each course was also collected when made available, usually online. Arrangements of observation times were synchronized during these meetings as much as possible during this interview, although this continued through the early part of the semester.

Communication via email, phone, or in person was made with the instructor before each observational episode in the semester. This was necessary in order to understand the context of the particular material to be covered for that day and to get an idea of potential activities in small groups. At times, the context of a particular class for that observational period could be arrived at through the online calendar for that particular class. Required pre-class materials to be worked on by students was made available to the observer for some classes. At the end of each observation period each instructor or TA was asked to give their estimation of complexity of student engagement or activity level for both the particular observed small groups and the whole class for that day. After the final in-class observations of the semester were finished, each instructor was interviewed to discover their estimates of engaged AL behaviors for the semester

as a whole, was given a brief summary of the research at that time, and were asked for any additional comments they might have. Additionally, they were furnished insights and suggestions to increase student engagement if they so desired. Appendix I lists the questions used for the final interview.

In-class data and observation protocol. Classroom data were collected on days pre-determined with each participating course instructor. Selection of dates required that there was a small-group activity planned for that particular day. Once specific days for observation were chosen, the primary investigator rapidly drew out the room architecture, seating arrangements, noted the number of students, the number of instructors or teaching assistants (TAs), and any other notable classroom characteristics. Notations were written on the CLOSE SCALE instrument. The moment small groups were established, the new seating arrangements were noted. Depending upon the arrangement of the rooms, groups were rapidly numbered for randomization purposes. The mapping of groups was done from the instructor's perspective facing the room clockwise from left to right.

After this map was made, for each class during the first group observation, one or two of the small groups, depending on observers' availability, were chosen with a random number generator application on a cell phone. During the first observation both observers observed the same group at the same time to establish acceptable inter-observer reliability. If the actual active-learning exercise was not known before class, it was quickly assessed and placed into the

proper category according to the *Active Learning Inventory Tool* © 2006 descriptions of types of active-learning exercises (Van Amburgh et al., 2007) or a new activity was added according to the instructor's categorization of both type and difficulty level.

The CLOSE SCALE instrument in Appendix E was used to record observations in the small groups. In order to catch the nuances of engagement it was necessary to be in close proximity to the students. Once the above notations are recorded for the particular student-centered active-learning exercise, observers moved into place to start the student engagement observations. After IRR was established, separate groups of students were observed by the observers. These groups were determined with the random number generator. The observer remained with that group for the duration of the activity.

Initially, observations were to be conducted with a timer pre-set for one minute with a ten second rest between observations of individual students. The ten second rest period was eliminated in a pilot test on day one. The rest period was not needed and actually had the effect of observers missing details needed to make proper assessments of student engagement. A stopwatch and timer app was downloaded from the Internet and was used on a Samsung Note3 Smartphone for the primary investigator and on a Samsung S5 Smartphone for the trained observer. The timer portion of the app was pre-set for repeat minute count-down with three second vibrations. This enabled the observers the ability

to see the large font countdown and hear the vibrations without distracting the students and without interfering with the observations.

Observers started each observation with the student directly opposite their forward view if students were in a circle. There was a short amount of time normally before activities were started that allowed for observers to record any initial observations on the CLOSE SCALE instrument, to set clocks, arrive at proper groups and get seated. Normally, the observation period would start the moment the activity began. Each individual in the group was observed for one minute and then the observer would move clockwise around the group to begin to observe the next individual. Engagement levels for each minute were noted with a single tally on the observation instrument shown in Appendix E. Whenever a group was in a horizontal formation, observation began with the student on the left side facing the observer. Before the first observation was made, general activity notes were made on the SCALE portion of the observation instrument.

For the CLOSE portion of the checklist, the sex of each student was noted starting with the student directly opposite the observer and moving clockwise around the table. Once the exercise began, a tally mark was placed for the highest level of complexity of CLOSE achieved during that one minute time interval starting start with the individual directly across from the observer. The level of complexity was noted using examples of complexity levels by mode of engagement denoted by the *ICAP Framework* in Appendix B.

Off-task student engagement is assigned a numerical value of 0. Off-task behaviors shown by students include: playing on smartphones in material not related to learning, eyes wandering around the room, or talking to class members about subjects not related to the learning objectives. A passive level of complexity is denoted by “P” in the ICAP framework. This level is assigned a numerical value of 1. In the passive level, the student is engaged and on-task. Examples of on-task passive receiving modes of engagement include: listening without doing, reading without doing or watching without doing. These examples of engagement represent the lowest level of on-task engagement.

The second level of on-task engagement is called active manipulating and is denoted by “A” in the ICAP framework. It includes activities such as taking notes, underlining or highlighting, manipulating a video, rotating objects, looking, nodding, searching, copying, gesturing, pointing, selecting, and even gazing. These are all considered to be on-task levels of cognitive engagement. This level is assigned a numerical value of 2.

The third complexity level of engaged overt behavior is that of constructive generating denoted by “C” in the ICAP framework. This includes behaviors such as out-loud reflection, drawing concept maps, asking questions, self-explaining, taking notes in one’s own words, explaining concepts, production of new outputs, meaningful elaborations, asking questions, comparing and contrasting cases, posing problems, integrating text and diagrams, making plans, drawing

analogies, reflecting and monitoring ones' own understanding, and constructing timelines. This level is assigned a numerical value of 3.

The highest level of complexity of engagement is that of interactivity. This level is denoted by "I" in the ICAP framework. Interactivity must take place between at least two people and necessitates at least pairs working together in some way. Interactive modes of engagement include defending and arguing a position, asking and answering comprehension questions with another person, debating with a peer, discussing similarities and differences. These joint dialogues must entail the partners or group making substantial contributions to the topic, and basically coming up with new ideas collaboratively (Chi & Wylie, 2014; Chi, 2009). This level is assigned a numerical value of 4.

Both observers memorized the basic modes of engagement behaviors during the pilot tests before actual data were collected. The engagement behaviors were placed on index cards for quick reference during observations. Observations continued in a clockwise fashion throughout the student-centered active-learning exercise as illustrated in Appendix J. During the rest periods between student-centered active-learning exercises, observers recorded additional observations on the CLOSE SCALE instrument. Any activities not found in the *Active Learning Inventory Tool* © 2006 were noted.

Note with the illustration in Appendix J, if the process continues beyond 10 students, the first observed student becomes the eleventh observation, the

second the twelfth, and so on. In like manner, in the second illustration in Appendix J, the first observed student becomes the fourth observation in the second round, the second becomes the fifth observation and so on until the student-centered active learning exercise is finished. If more than one student-centered active-learning exercise occurred in a class period, the observers rapidly remapped seating arrangements and group arrangements. They randomly picked new groups and repeated the above steps for observation of engagement of student-centered active-learning exercises. Specific overt engagement behaviors that were focused on in the study are shown in Appendix D.

Summary

The materials and methods listed above show how this study was organized and conducted. After initial interviews with instructors, classes were observed using a newly designed observation checklist that was combination of a framework for measuring overt engaged student behaviors during learning activities and an active-learning inventory tool. Questions for the study were answered as data were analyzed from the CLOSE SCALE observation tool.

Eight classrooms were sampled for the study with a total of 60 separate observations.

Chapter 4

Findings

This section includes findings on observational classroom demographics, inter-rater reliability, research questions, and instructors' interviews. The raw class observational data is found in appendices K and L. The raw inter-rater reliability data is found in appendix M.

Classroom Demographics

The courses sampled for this study were selected based upon the above requirements stated in Chapter 3. Table 3 provides a description of the observed classes, how many times activities were observed, small-group sizes, normal complexity levels of SCALE, and observation dates. Abbreviations given in the table for each course are followed for the remainder of this paper.

Table 3. Sampled courses.

Course	***Class Size***	***Group Sizes***	***SCALE Complexity***	***Obs.***	***Observation Dates***
Basic Calculus (M125)	23-25	3-5	moderate	9	1/25, 2/1, 10, 24, 3/9
Compos/Gramm Rdgs (SP300)	10-12	2,3	moderate-high	9	1/29, 2/1, 5, 8, 10, 22, 24
Greenhouse Management (PS430)	13-31	3-7	high	9	2/11, 25, 3/10
Interpreting Research Findings (PS331)	12	4	moderate	4	2/17, 24
People and Environment (G345)	39-40	3,4,12	low-moderate	8	1/25, 29, 2/3, 5, 10, 19
Textual Analysis (SP330)	15-19	2,3	high	11	1/27, 29, 2/1, 3, 5, 8, 10
Turfgrass Pathogens (PS 438/538)	9	3	moderate	2	2/25
Water Resources (G436)	38-42	2-4	low-moderate	8	1/19, 26, 28, 2/11, 25

Small-group Observations

Classes and activities were observed by observers apart, by observers together but with different groups, and by both observers and same groups to check for inter-reliability. Table 4 provides a summary of these factors. Observer 1 was the primary investigator. Observer 2 was the trained observer and was not available for as many class periods. This is reflected in the total number of observations. Occasionally, it was necessary for observers to rate classes separately when class time periods were in conflict.

Table 4. Frequency of small-group observations.

	Observation frequencies				
	Classes observed alone		**Same class period, different groups observed**		**Same Groups**
Course	**Obs. 1**	**Obs. 2**	**Obs. 1**	**Obs. 2**	**Obs. 1 and 2**
M125	4	0	2	2	1
SP300	4	1	1	1	1
PS430	2	0	4	3	0
PS331	0	0	2	2	0
G345	5	1	1	1	0
SP330	3	0	4	4	0
PS438/538	0	0	1	1	0
G436	2	0	2	2	1
Totals	**20**	**2**	**17**	**16**	**3**

Note: Obs. 1 is the primary observer, Obs. 2 is the trained observer.

Inter-rater Reliability

The IRR for the YouTube classrooms was found to be highly reliable (2 items; Cronbach's α = .98) with 25 of 27 cases included in the calculation. Reliability of raters was checked on the first day of class in Calculus and Geography classes. Inter-rater reliability was also checked during the latter part of the overall

observation period (mid-semester) in Geography, Calculus, and Spanish classes for a total of eight separate incidents. Inter-rater reliability (IRR) was found to be highly reliable for 25 cases (2 items; Cronbach's α = .98). The first checks on inter-rater reliability were made before classes started (pre-semester) with YouTube observations as described in Chapter 3. Inter-rater reliability was greater than 0.70. This high reliability continued throughout the study for early and mid-semester observational checkpoints as shown in Table 5.

Table 5. Inter-rater reliability between the two observers.

		Reliability Measures	
Checkpoint timing	***Classes Observed***	***Complexity of Activity***	***Cronbach's Alpha***
Pre-semester	YouTube (5 classes)	Moderate	.979
Early semester	M125, G310, G345	Low - High	.982
Mid-semester	M125, G436, SP300	Moderate	.958

Findings on Research Questions

Research question 1. What proportion of total class time in a FLIP classroom is typically spent in student-centered active-learning exercises (SCALE)?

This is a simple ratio of time spent in the student-centered active-learning exercises during class periods under observation. The aggregate time of all classes observed was 2025 minutes. The aggregate time students were in

activities in small groups was 1035.5 minutes. Students were involved in small-group activities for 51.1% of the time they were under observation. The proportion of time spent in small groups for each observed course is shown in Table 6.

Table 6. Small-group demographics during observations.

Course	***Obs.***	***M***	***F***	***Time in Small Groups (min)***	***Class Time***	***Time in Small Groups (%)***
Basic Calculus (M125)	9	24	18	99	250	39.6
Compos/Gramm Rdgs (SP300)	9	5	13	262.5	350	75.0
Greenhouse Management (PS430)	9	29	15	98	225	43.5
Interpreting Research Findings (PS331)	4	10	4	30	100	30.0
People and Environment (G345)	8	15	23	114	300	38.0
Textual Analysis (SP330)	11	13	11	304	350	86.8
Turfgrass Pathogens (PS438/538)	2	6	0	18	75	24.0
Water Resources (G436)	8	16	14	110	375	29.3
Total	**60**	**118**	**98**	**1035.5**	**2025**	**51.1**

Note: Obs. Is observation number.

Research question 2. Will students who participate in instructional activities classified at different levels of difficulty (as classified by the SCALE instrument) perform differently in terms of amount of time spent at different levels of overt student engagement as measured by the CLOSE instrument?

To test whether proportions of time spent were different in each group, I used a χ^2 test of independence with $\alpha = .05$ as criterion for significance. Table 7 shows that students that participated in instructional activities classified at different levels of difficulty by the SCALE portion of the instrument performed differently in

terms of amount of time spent at different levels of overt student engagement as measured by the same instrument. According to the χ^2 test of independence, differences between engagement and SCALE levels were statistically significant with χ^2 (6, N = 857) = 94.15, p < .0001. Figure 2 shows that student engagement levels differed with complexity of small-group learning activities.

Table 7. Time in levels of engagement across activity complexity.

	SCALE Level		
Engagement Level	***Low***	***Moderate***	***High***
Interactive	8 (21%)	151 (36%)	261 (66%)
Constructive	11 (30%)	123 (29%)	77 (19%)
Active	17 (46%)	134 (32%)	53 (13%)
Passive	1 (3%)	16 (4%)	5 (1%)

An unanticipated observation made early in the semester was that instructor interactions with students during small group activities had a marked effect on student engagement within the groups. As a result of this observation, tallies of students' engagement levels during these interactions were noted by circling the tallies. Student engagement was measured with and without these interactions. Table 8 shows the student engagement with instructor interactions with χ^2 (6, N = 1324) = 35.33, p < .0001.

Table 8. Time in engagement across activity with instructor interactions.

	SCALE Level		
Engagement Level	***Low***	***Moderate***	***High***
Interactive	8 (21%)	158 (27%)	271 (39%)
Constructive	12 (32%)	156 (26%)	133 (19%)
Active	17 (45%)	220 (37%)	252 (36%)
Passive	1 (3%)	58 (10%)	38 (5%)

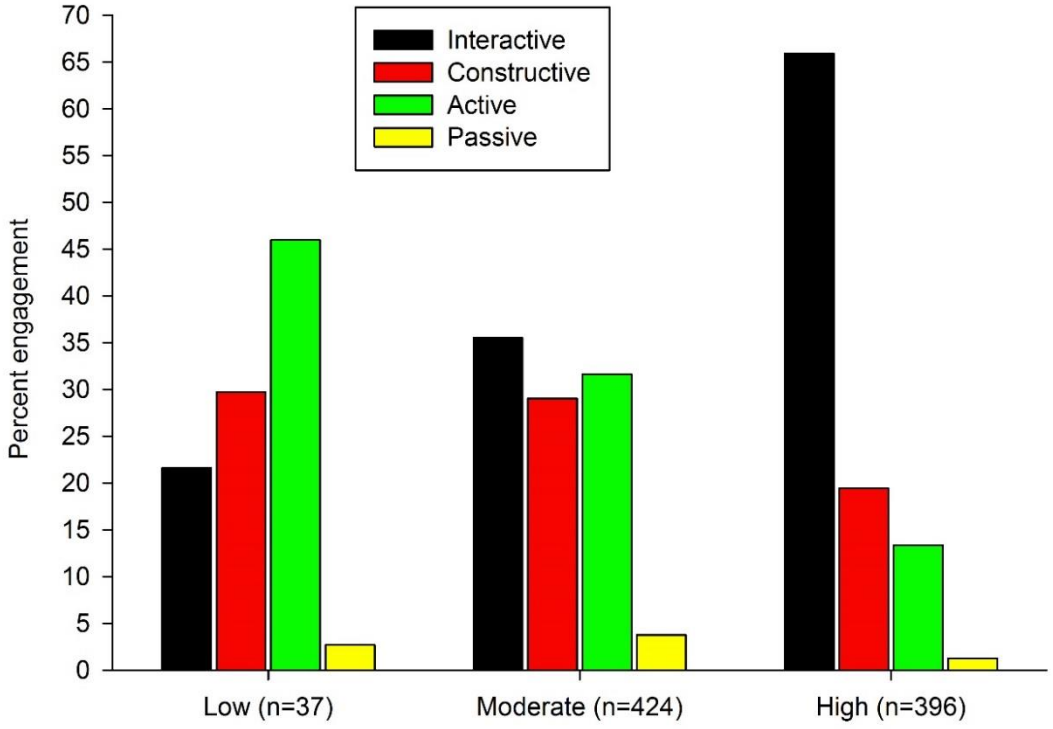

Figure 2. Engagement level of students across complexity of activity.

Research question 3. Will students in different sizes of small groups perform differently in terms of amount of time spent at different levels of overt student engagement as measured by the CLOSE instrument?

For this research question the passive level of engagement and the group size of 12 students had too few observations to be included in the analysis. To test whether proportions of time spent in different levels of engagement were different with group size, I used a χ^2 test of independence with $\alpha = .05$ as criterion for significance. Table 9 shows that there were differences in student engagement with group sizes. According to the χ^2 test of independence, differences between engagement and group size were statistically significant with χ^2 (10, N = 828) = 107.52, $p < .0001$.

Table 10 shows that there were differences in student engagement with group size even with increased instructor interactions. According to the χ^2 test of independence, differences between engagement and group size were statistically significant with χ^2 (10, N = 1220) = 87.93, $p < .0001$. Figure 3 illustrates the time students are engaged across group sizes including the passive and off-task behaviors.

Research question 4. How do instructor estimates of whole class student engagement during small-group activities correlate with student engagement as measured by the CLOSE SCALE instrument (complexity moment)?

Not only were instructor estimates of whole class student engagement values

Table 9. Time in levels of student engagement across group size.

	Group Size					
Engagement Level	***2***	***3***	***4***	***5***	***6***	***7***
Interactive	150 (59%)	86 (56%)	98 (40%)	24 (24%)	53 (84%)	9 (64%)
Constructive	77 (30%)	29 (19%)	64 (26%)	31 (31%)	6 (10%)	2 (14%)
Active	26 (10%)	38 (25%)	84 (34%)	44 (44%)	4 (6%)	3 (21%)

Table 10. Time in levels of engagement across group size with instructor interactions

	Group Size					
Engagement Level	***2***	***3***	***4***	***5***	***6***	***7***
Interactive	157 (30%)	92 (37%)	102 (37%)	24 (24%)	53 (83%)	9 (64%)
Constructive	137 (26%)	46 (19%)	75 (27%)	33 (33%)	6 (9%)	2 (14%)
Active	227 (44%)	107 (44%)	98 (36%)	44 (44%)	5 (8%)	3 (21%)

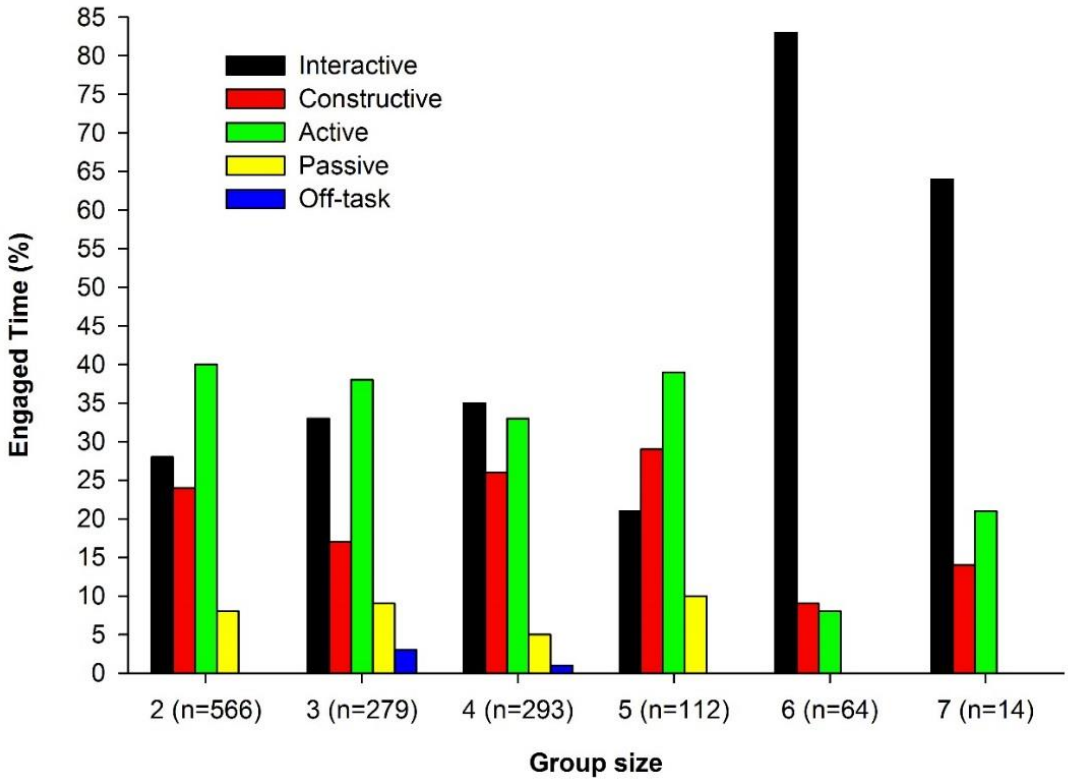

Figure 3. Engagement level across group size with instructor interactions.

determined but also instructor estimates for the specific groups under observation. The instructor estimates of student engagement in observed groups and the complexity moments for those groups were significantly correlated, $r(56) = .38$, $p < .01$. No significant relationship was found between instructor estimates of student engagement for the whole class and the averaged complexity moments of the two observers, $r(17) = .27$, n.s.

Additional Findings

Interview findings. A brief summary of interview findings is presented in Table 11. Complete summaries of the pre-observational and post-observational interviews with the instructors are found in Appendices H and I. All instructors had a least 10 years of teaching experience. Only one course was considered to use a total FLIP pedagogy. In this calculus class the instructor had 23 sections with 675 students and 12 teaching assistants. The instructor presented all of the required basic concepts through youTube videos that students were supposed to view before coming to class. Students worked problems individually and in groups during class.

Table 11. Brief summary of instructor interviews.

Course	***Yrs. Teaching***	***FLIP Semesters***	***FLIP Type***	***Engagement Estimate***	***Act.Time (%)***	***Eng. Time (%)***
M125	20+	8	Total	4.0	50	75
SP300	10	6	Partial	3.5	60	95
PS430	32	0	Partial	3.8	80	85-90
PS331	15	6	Partial	2.0	45-50	50
G345	12	8	Partial	3.0	33	100
SP330	22-23	12	Partial	2.0	80	85-90
PS438/538	15	6	Partial	2.0	45-50	50
G436	12	8	Partial	3.5	33	100
Total	140	54	—	—	—	—
Average	17.5	6	—	3.0	53	81

Note. Act. Time refers to the instructor's estimate of the class time students were in group activities. Eng. Time refers to the instructor's estimate of time students were engaged in those activities.

They also used clicker technology to answer problems individually in class. All other courses used a form of partial FLIP in which at least some course material

was covered during class although in the Spanish classes students covered the vast majority of the conceptual material before coming to class. The number of semesters that instructors had previously used a FLIP model ranged from 0 to 12, with an average of 6. The average estimated perceived level of student engagement by instructors across all courses was 3. This number corresponds to the “constructive” level of student engagement. The average estimate proportion of time that instructors perceived their students spent in small-group activities during observed classes was 53% which is very close to the actual 51.1% shown in Table 4. The average estimated time in which instructors perceived students were engaged during the small-group activities was 81% with a range of 50 to 100%. Further analysis of interview tables as well as other observations for each class will be provided in Chapter 5.

Chapter 5

Discussion

In chapter 1 it was mentioned that there are gaps in the research regarding the relationships between small group size, student engagement, and student-centered active-learning exercises in FLIP approaches. The purpose of this study was to examine the relationships that exist between these variables. Several different classes were observed where instructors utilized a FLIP, whether partial or total. In these classes four major questions were addressed in the research. Observations were gathered using a tool developed specifically for measuring fine-grained overt student behaviors within student-centered active-learning exercises in small groups, the CLOSE SCALE tool. In this part of the paper the results of the four questions asked in the research will be discussed. The section that addresses the major research questions will be followed by a general discussion of engagement in each course setting where the different classes will be characterized. Following this will be a conclusion to the paper as well as proposed future research.

Discussion of Questions

The paragraphs below will discuss the research findings related to each of the previously described research questions. Following this will be a discussion of findings not directly related to the research questions.

Research question 1. What proportion of total class time in a FLIP classroom is typically spent in student-centered active-learning exercises (SCALE)?

Question 1 was raised to get an idea of just how much time was being spent in the FLIP classrooms in active learning by students in their small groups. This was necessary to establish some sort of baseline of small-group activity in the in-class portion of the FLIP classrooms. This question was important because FLIP classroom models are purported to be active-learning classrooms which emphasize collaborative learning in small groups. Therefore, there was a need to determine the proportion of time spent in small-group learning compared to the overall class time. Instructors may, in fact, think that they are spending more time in active-learning situations than is actually occurring. In fact, Table 6 illustrates that for the 2025 minutes that were observed in the eight classrooms, only a little over half of the time (51.1%) was spent in active-learning exercises in small groups. This is a little surprising when one of the claimed benefits to a FLIP model is the active-learning aspect. Instructors utilizing a FLIP may still be lecturing on basic concepts more than they realize. It must be noted, however, that this average was over a large range, 24-87%. Some observed classes provided longer small-group activities than others.

In a large faculty survey (n = 6768) extensive lecturing was found to be the primary method of instruction at the secondary level of education with 63% of the

courses taught (Hurtado, Eagan, Pryor, Whang, & Tran, 2012). A more recent observational study specifically examined engaged active learning within Science Technology Engineering Math (STEM) lecture settings. In these settings extensive lecturing was found to be at about the same level (64%) as in the large faculty survey mentioned earlier (Hora, 2015).

Hora (2015) investigated student engagement at the fine-grained level in similar fashion to this study and used a similar tool, minus the passive engagement category of the CLOSE SCALE tool. In his study, the analysis was limited to two activities for each category to detect the interactive, constructive, and active engagement levels. These are three of the four engagement categories found in the ICAP Framework. Hora determined which activities were most prevalent during lectures and settled on six activities, two for each category. He labelled these activities as Differentiated Overt Learning Activities (DOLA) quite similar to the Student-centered Active Learning Exercises (SCALE) mentioned in the present study. Based upon his extensive observation of lecture classrooms he determined that the active level was to be represented by student responses (clickers) and problem-solving; constructive level by student novel questions and creating; and interactive level by creating and peer interactions. His activity tool was very similar to my own and also based upon the *ICAP Framework* minus the passive category (Chi & Wylie, 2014). While these two STEM studies showed approximately 14% more active lecturing than this present study, it must be remembered that some of the observed FLIP model classes in

this study had very high proportions of time that students were engaged in small-group activities, up to 87%. In his study, Hora (2015) points out that most lectures were far shorter than is often thought and many more active-learning episodes happen in “normal” lectures that are often reported. His goal was to do a fine-grained study of engagement in lecture settings similar to the present goal of a fine-grained engagement study in a FLIP pedagogy. The need to get more detailed information on engagement was perceived in both studies. Hora (2015) perceived that more engagement might be occurring in a lecture setting than has been reported and felt that the best way to detect engagement was by using a fine-grained observational study.

Table 6 shows that the percent of time students were in small groups ranged from a low of 24.0% in a Plant Sciences course (PS438/538) to a high of 86.8% in a Spanish course (SP330) that analyzed Spanish literature. This wide span of time spent in small groups may relate in some way to the difficulty of the materials that needed to be covered and the necessity to use small groups with the materials. Table 3 shows that the language courses (SP300, SP330) employed moderate to high complexity levels of SCALE while Water Resources (G436) and Turfgrass Pathogens (PS438/538) employed low to moderate SCALE activities. The language courses utilized small groups to a much higher degree than did the latter two Geography courses. This might be a reflection of course difficulty, activity complexity or a combination of both. Interestingly, in post-observation interviews shown in Table 11, the range that instructors

perceived their students to be in small groups was from 33-80%, again a wide range. This range fairly well reflected the observed times students spent in small groups for those courses. The courses that had the highest proportions of time with students in small-group activities were slightly underestimated by the instructors. The courses that had the lowest proportions of time with students in small-group activities were slightly overestimated by the instructors. This indicates that instructors are fairly attentive as to how much time they are having students spend in small group activities. This time consciousness may reflect their particular learning objectives for their courses.

Research question 2. Will students who participate in instructional activities classified at different levels of difficulty (as classified by the SCALE instrument) perform differently in terms of amount of time spent at different levels of overt student engagement as measured by the CLOSE instrument?

This question was asked because it is important to find out what the relationship between the degrees of difficulty of a student-centered active-learning exercise activity is with the observed student engagement level in the small groups. It is particularly important if an instructor desires a certain level of engagement. Table 5 shows that the more difficult an activity is, the higher the engagement level. A high-level of difficulty with student-centered active-learning exercises resulted in 45% more interactive engagement among students when compared to low-level student-centered active-learning exercises activities. It must be remembered that interactivity in the ICAP Framework means that

students interact together in a fashion that results in construction of knowledge that was not previously there. Moderate-levels of student-centered active-learning exercises resulted in more even levels of engagement with interactive, constructive, and active engagements all at approximately 30%.

Low-level student-centered active-learning exercises resulted in a majority of time spent in the active level. The active level of engagement denotes motor activity on the part of the student but no constructive behavior. Figure 2 illustrates that with the moderate-level of a student-centered active-learning exercise, student engagement in learning is fairly even across the top engagement categories. However, the interactive engagement is 15% higher than interactive engagement with the low-level student-centered active-learning exercise. When complex activities were utilized in a small group, students spent a higher amount of time at the interactive engagement level ($n_0 = 261$) than was expected ($n_e = 62$). In contrast, when low complexity activities were utilized in a small group, students spent a lower amount of time at the interactive engagement level ($n_0 = 8$) than was expected ($n_e = 12$). According to the χ^2 test of independence, differences between engagement and SCALE levels were statistically significant with χ^2 (6, N = 857) = 94.15, $p < .0001$. We can indeed infer that students will engage at higher modes of engagement when more complex levels of SCALE activities are available.

Table 6 shows the relationship between SCALE and student engagement

when instructor interactions are included in the analysis. The trends here are similar to those without instructor interactions but are not as strong. Interactive and constructive engagements drop off markedly for the high-level SCALE, in essence at half of what they are without instructor interaction. An implication here is that instructors may want to carefully weigh how much they interact in any given student-centered activity. A certain amount of coaching and scaffolding may be necessary but if constructive interactions are to occur within groups by the students, the instructor interactions may need to be kept to a minimum.

Research question 3. Will students in different sizes of small groups perform differently in terms of amount of time spent at different levels of overt student engagement as measured by the CLOSE instrument?

For this question, the “passive” level of the *ICAP Framework* was not included due to the lack of minutes students were at that level. The null hypothesis proposed that students would not perform differently in terms of the amount of time they spent at different levels of overt student engagement as group sizes were changed. The χ^2 test with $p < .0001$, demanded that the null hypothesis be rejected. We can infer that students will engage at different levels when in different sized groups. I used a χ^2 test of independence with $\alpha = .05$ as criterion for significance. Table 7 shows that there were differences in student engagement with group sizes. For example, in a group size of two, students spent a higher amount of time at the interactive engagement level ($n_0 = 150$) than

was expected (n_e = 128). In contrast, in a group size of five, students spent a lower amount of time at the interactive engagement level (n_0 = 24) than was expected (n_e = 50). According to the χ^2 test of independence, differences between engagement and group size were statistically significant with χ^2 (10, N = 828) = 107.52, $p < .0001$.

All group sizes, except for sizes of four and five, had students that reached the “interactive” level of the *ICAP Framework* (Chi & Wylie, 2014) for a majority of the observations. The fact that these groups had students engaged at the “interactive” level meant that the interactions between students were constructive in nature and knowledge was being created in some fashion. The expectation was that the smaller group sizes would result in the highest levels of engagement and that those groups with the largest number of students would see engagement with a majority of students at lower levels such as “active” or “passive”. It should be remembered that according to the *ICAP Framework* (Chi & Wylie, 2014), the student at the “passive” engagement level is still considered to be engaged in learning. In order to be disengaged a student must be off-task for the majority of the observation minute. The fact that group sizes of six and seven had high engagement seems to be more a reflection of the complexity of the SCALE activity and possibly the self-determination of the students allowed for by the instructor. Both of these group sizes were in PS430, a Greenhouse Management course, in which the activities were centered on group projects with

a large portion of their grades dependent upon the projects. Students in this class were given a great deal of freedom to choose the projects and how they would be implemented, thus, had high self-determination. This may have also increased the engagement levels above expectations.

In similar fashion Table 8 shows when instructor interactions were included in the analysis, the null hypothesis had to be rejected, $p < .0001$. In a group size of two, students spent a lower amount of time at the interactive engagement level ($n_0 = 157$) than was expected ($n_e = 186$). In contrast, in a group size of six, students spent a higher amount of time at the interactive engagement level ($n_0 = 53$) than was expected ($n_e = 23$). According to the χ^2 test of independence, differences between engagement and group size were statistically significant with χ^2 (10, $N = 1220$) = 87.93, $p < .0001$.

Tables 7 and 8 show the actual statistical results after the passive level of engagement was excluded. There were not enough numbers to include the passive level in the analysis. Figure 3 shows differences in small-group engagement with group sizes with the instructors' interactions included. Only the Greenhouse Management course with students in groups of six or seven resulted in a majority of students at the interactive level. These tables are very similar to the DOLA concept that looks at only the active forms of engagement (Hora, 2015) to the exclusion of the passive level of the *ICAP Framework* (Chi & Wylie, 2014). Figure 3 includes all levels of the *ICAP Framework* as well as the off-task

disengagement to illustrate the amount of engagement time spent at these levels. Groups of two to five individuals had their highest levels of engagement at the active level. The lower engagement in groups of three and four was most likely a reflection of the type of SCALE activity as explained earlier. However, the reduction in engagement in groups of two and three students is best explained with the increased instructor interaction with students. These group sizes were most often in the very active Spanish classes that had complex activities. Instructors would, at times, interrupt activities to probe, coach, facilitate, and ask questions of students. These interactions by instructors can break up the flow between students which is necessary to achieve the higher levels of engagement that require constructive behaviors.

The instructor in the Greenhouse Management class interacted very little with the students allowing them a great deal of freedom in working out their management projects as teams. Note that students rarely were at the passive level of active engagement. This means that, while in small groups, students in FLIP model classrooms were actively engaged in interactive, constructive, or active modes. This is a very positive aspect of the study illustrated by Figure 3. The only group sizes that showed any real off-task behaviors were groups of three and four students. Group sizes of three and four students were often found in courses that had activities that were the least complex.

When instructors interacted more with their students, interactive engagement decreased in groups of two by 29%. Interactive engagement decreased in groups

of three by 19% when instructors increased interaction with students. These groupings most often occurred in courses that had complex activities such as in Spanish courses. It does not necessarily mean that all of the interactions by the instructors were negative. Often in language courses instructors are coaching and facilitating. However, the drop off in constructive knowledge “creation” (the interactive level of engagement) between students is very. Often, in the Spanish courses there were several mini-activities within the longer activity. Some of the interruptions were necessary for rapid instruction, and part of the time students were providing verbal communication to questions asked by the instructors. Again, this is a necessary part of a language classroom but might need to be held to a minimum. Similar types of interruptions did not occur in the Greenhouse Management course where students were working on projects as teams. In that case there was only a 1% drop off in interactive engagement.

Research question 4. How do instructor estimates of whole class student engagement during small-group activities correlate with student engagement as measured by the CLOSE instrument (complexity moment)?

The final question of this study addresses the ability of instructors to perceive student engagement by approximating a number representing activity or engagement within observed groups as well as for the whole classroom. This can be quite important to get a rapid idea of how engaged students might be in a particular class. If estimates are similar to fine-grained observations by trained observers, instructors can adjust their activities to align with their course

objectives in a formative fashion. Instructors' estimates of student engagement in the observed small groups were moderately positively correlated to the calculated complexity moments, $r(56) = .38$, $p < .01$. When instructor estimates of student engagement for their classes as a whole were compared to the average of both observers calculated complexity moments, no significant relationships were found, $r(17) = .27$, n.s. There were only 17 times that both observers were able to rate groups together which limited the number of objective complexity moments that could be averaged to correlate to the whole class estimates of the instructors. This may have somewhat lessened the potential for significance with the correlations. In some classes 11 groups were in SCALE activities at the same time. The instructor would have been rating all of them while observers were only investigating two groups. This shows a potential limitation of the study.

General Discussion on Student Engagement

This portion of the paper covers a general discussion on student engagement and characterizations of the classrooms that were studied. Drawing upon results from the major questions, from the instructor interviews, and from general observations during the in-class investigation the following should be mentioned. The architecture and seating arrangements of the classrooms seemed to have had an effect on engagement. The difficulty of courses and the learning materials may also have influenced engagement. Instructor approaches to the activities may have also influenced engagement. Finally, the degree to which students could control their activities may have played a role.

Each of these factors will now be examined after a characterization of each course and classroom. This portion will examine the courses in the order they were presented in Table 3 of sampled courses.

M125.

Instructor, course, engagement activities, and class characterization. This instructor utilized a full FLIP model for her Basic Calculus course. She has used the FLIP model for eight semesters and attended special training on the pedagogy at the Summer Institute. In her course she had 675 students in 23 sections. In order to deliver basic concepts to her students she created a YouTube channel where students viewed her instructional videos. The instructor mentioned, in the post-observational interview, that sometimes only half of the class had viewed the videos. The instructor was able to see how many “hits” were on her YouTube channel and this was shared as a grave concern. In this course there were 13 Teaching Assistants (TAs) that helped students with in-class activities. The instructor worked directly with one small section in class (*n* = 8). Most sections were comprised of 25 students in a classroom.

In-class activities were comprised mainly of worksheet problems done in groups, individual and group clicker questions, and quizzes/exams. The level of the activities was moderate. Only 40% of the time was spent in small-group activities which was less than the average. For a pure FLIP model this might need to be increased. The materials were moderately complex but students in

observed groups had a tendency to work individually rather than corporately on problem-solving. During group activities in the observed section, students were normally in groups of four or five, shown earlier to be sizes with the least interactive engagement. These sizes were earlier shown to be the same sized groups that often had less complex activities for students to work on. The instructor gave an engagement estimate for her section as 4, the highest level possible. The section observed by the observers did not function at such a high engagement level and was facilitated by a TA. This may reflect the individual TA's approach to the class. While the difficulty of the course material was moderately complex, the activities were not always particularly complex and students tended to work on problems individually.

Architecture and seating arrangements. The observed section classroom had a wide-open feel and rolling desks that easily afforded small-group activities. However, desks needed to be rolled as closely together as possible in circles with students facing each other for maximum engagement. This was not always accomplished and a single desk being slightly out of order seemed to affect the whole group and lessen engagement. The room should have been ideal for highly-engaged group learning.

Instructor and the instructor's approach to students. The instructor produced excellent teaching videos that took students step-by-step through worksheets designed to teach the basics of calculus online. On the other hand the TA seemed to approach the activities in an off-hand manner, sometimes

ending activities rather abruptly and never really encouraging students to move in close. He rarely reminded them that engagement in the activities as a group was essential. This may have been a factor that lead students to engage at lower levels.

Student control of learning. Students did not have much control of their learning in this class. They along with the TA, seemed to follow a tightly scripted schedule. While there was a lot of material that was fairly complex to cover, activities might have been planned to give students a little more control. There was not a lot of room for self-determination of learning.

SP300.

Instructor, course, engagement activities, and class characterization. The instructor in this Partial FLIP Spanish Grammar course was a native Mexican with 10 years of teaching experience. She has used the FLIP model for six semesters and attended special training on the pedagogy at the Summer Institute. She indicated in her pre-observational interview that she probably had used the pedagogy before this but did not have a label for it and is now consciously using it. She was very active in the room and utilized some media both before and during classes. Students were expected to come prepared to interact with each other during class. Engagement activities usually centered on grammar worksheets with 75% of the time spent in group activities of 2-3 students. The levels of SCALE activities were moderate to high. The class size was small (10-12). This class was very engaged.

Architecture and seating arrangements. This classroom had a wide-open feel and rolling desks that easily afforded small-group activities. However, desks needed to be rolled as closely together as possible in circles with students facing each other for maximum engagement. In this classroom there was more of a tendency for students to sit in a horizontal fashion. If they would face each other engagement might improve.

Instructor and the instructor's approach to students. This instructor was very involved with her students. As the semester progressed she was more cognizant of the need to get students active by urging them to move their desks to more favorable positions. As students got to know each other better their engagement levels improved. This instructor was quite animated in her approaches. There were times when engagement levels would lower as teacher interaction would increase. Less instructor interaction may result in more knowledge creation with students.

Student control of learning. Students did not have much control of their learning in this class. While there was a lot of material that was fairly complex to cover, activities might have been planned to give students a little more control.

PS430.

Instructor, course, engagement activities, and class characterization. While this instructor has over 30 years of teaching experience this was his first time using a FLIP pedagogy on the student project portion of a Greenhouse Management course. He had not attended special training on the pedagogy at

the Summer Institute but indicated in an email that he watched YouTube videos, a PBS program and attended seminars on the subject. His comments during the post-observation interview were so extensive that a separate page of Appendix O was required for his answers. He is not yet sure if the FLIP model is a success and would like to compare the project results to those of previous years. The proportion of time spent in small groups was less than half of the overall class time. The first part of each session was spent primarily in lecture with an occasional guest speaker. The second part of the period was spent in small-group planning sessions and students were in highly engaged groups. The material for the projects was quite complex and individual members took on different roles in order to fulfill the projects. They were expected to place materials in a discussion board online on a consistent manner and timely fashion. This was the only class that had large groups. Groups would range from three to seven, depending on the day and which groups were observed. When the class was in small-group activities the groups were highly engaged, very motivated and very communicative. Class size ranged from 13-31 but was officially on the high end.

Architecture and seating arrangements. Architecture of the room was amphitheater style with desks fixed and pointing one direction. If students were to work together in a large group they would have to creatively sit in chairs and swivel backwards to face each other. In one case a group of six students appeared to start off very non-engaged. They were all facing the same direction

toward the front of the room. When one student got up, moved around and sat on a desk facing the rest the whole engagement level changed rapidly and from then on was at a very high level. This illustrates that while a room might not be amenable to small-group engagement, creativity on the part of students' arrangements can positively affect student engagement in activities.

Instructor and the instructor's approach to students. This instructor was very strict with expectations of his students reminding them strongly that they would be graded on their group projects. Also, he emphasized strongly that his reasoning for using small groups was in great part due to the requests of future employers to have workers that could both communicate well and work cooperatively in teams. This was the major reason that the instructor gave for trying a FLIP model.

Student control of learning. While the professor strongly admonished his students concerning grades, jobs, and expectations on the project, his overall approach during the project activities was very hands-off. He only approached students when they requested help or to check on their progress from time-to-time. The students had a great deal of control of their learning in the projects and this likely led to the very high, interactive engagement levels, even in the larger groups of students. Self-determination was high. This probably increased the engagement levels as well as the complexity of the projects.

PS331, PS438/538.

Instructor, course, engagement activities, and class characterization. While the instructor of these courses has previously used video in pre-class activities, this semester he did not. He expects his students to come prepared having done proper readings ahead of class. He has used a FLIP model for six semesters and attended special training on the pedagogy during the Summer Institute at the University. In addition, he invited Dr. Lodge McCammon for a special seminar given at the University on the FLIP model (McCammon, 2013).

Engagement activities for both of these classes were overseen by teaching assistants (TAs). The engagement activities were all moderate in difficulty. The activities were given the name ponderables (a new category to be added to SCALE), in which problems in research layouts and Turfgrass pathogens were “pondered” by students in small groups. The ponderables were not always as simple as they appeared on the surface and the students were seen developing concept maps and diagrams in order to model some of the ponderables. These activities were estimated to consume about 50% of the class periods but were observed to last for approximately 30% of the periods. Students seemed to take a while to get started on the activities.

Architecture and seating arrangements. Architecture in this class room was open but seating was in long rows facing the front. Students had to physically turn around to get involved and did not always get as close as they

might have. This was only one of the few classes where I recorded a student totally off-task. A particular student checked out basketball scores two times for a full observation minute and received two off-task tallies.

Instructor and the instructor's approach to students. TAs were used to conduct these activities and were fairly non-interjecting. They supplied help when asked and made occasional comments. The TAs did not appear to have had much guidance into the direction of the activities. Students might have been a little more engaged if they had been encouraged to work together in a stronger fashion, if they had moved physically closer to one another, and if they had seen the purpose in the groups a little more.

Student control of learning. Students were allowed control of their learning ponderables. This probably influenced their level of engagement. Self-determination was fairly high.

G345, G436.

Instructor, course, engagement activities, and class characterization. This instructor teaches four courses. The instructor has not had formal instruction in FLIP models but researched them. Two of the Geography courses used partial FLIP models. Students were expected to come to class in both cases prepared to work in small groups. Small-group activities included small-group discussions, question and answers, think-pair-share, collaborative quizzes, and case studies. Activities in the courses spanned the complexity level from low to high. Observational raw data findings of these classes are found at the beginning of

Appendices K and L. Small-group activities in G345 lasted 38% of class time. In G436 small-group activities lasted 29% of the overall class period. The instructor's estimates of these times were quite close at 33%. The Geography classes as a whole included mini-lectures interspersed with activities, sometimes two in a class period.

Architecture and seating arrangements. The architecture the rooms was not particularly conducive to small-group activities. Seats were not fixed and could be moved around with some difficulty but were not always moved into the best positions. In G345, desks were in horizontal rows that were very long facing the instructor. The room was often too hot or too cold for comfort. It had pillars that blocked eyesight somewhat. While it was a wide open room it was quite difficult to hear the instructor and lighting was poor.

G436 was in a much newer building but seating was in long rows vertically facing the instructor. These desks were harder to move into groups than in G345. In this room it was again was difficult to hear, though not as bad as in G345.

Instructor and the instructor's approach to students. This instructor could probably get more engagement out of her students by strongly admonishing them to move closer together physically, first, and then by helping them to understand the importance of using small groups for their activities. Strongly stressing grades based on their collaborative learning in small groups might also increase engagement. The TA could be admonished to be more involved in the

activities. The collaborative quizzes were one activity that yielded fairly high engagement. In these quizzes students were allowed to work together to solve their quizzes.

Student control of learning. Students were allowed a lot of freedom in their small groups. This probably increased engagement more than the mostly moderate activities. Self-determination levels were high.

SP330.

Instructor, course, engagement activities, and class characterization. The instructor in this Partial FLIP Spanish Textual Analysis course was a native Columbian with approximately 23 years of teaching experience. She has used the FLIP model for 12 semesters and attended special training on the pedagogy at the Summer Institute. This class consistently had the highest levels of engagement with students constantly at the interactive level of engagement. Students were required by the complexity of the worksheet materials and the demand to speak in Spanish only to work verbalizing constantly to individuals in their group in order to complete the work. The instructor was very interactive keeping students on their toes every moment. The proportion of time that students were in small groups was nearly 87% of the time. Both estimates by the instructor were very close to actual values for student engagement and time in small groups. This class was a class that demanded a student be prepared or they would be totally lost. It consisted primarily of reading materials in Spanish literature that demanded close interpretation by the students working before

class on their own and then closely in groups of two and sometimes three in order to finish the work.

Architecture and seating arrangements. The architecture of this room while fairly open had desks in a large square and not conducive to move. Students normally worked in pairs and not facing each other. This worked well for pairs but when three were involved one student needed to face the other two, at least in a semi-fashion. All students were very active on their laptop computers during the whole period of active-learning small groups.

Instructor and the instructor's approach to students. This instructor demanded a lot of her students and would not allow them to speak in English. She had very clear objectives, started and ended exactly on time, and approached the class in a business-like manner. This along with the complexity of the course material seemed to keep the students engaged for much of the time at the interactive level. Similar to S300, there were times when the instructor's questions could draw away from the interactive level within the group but these coaching times were probably necessary.

Student control of learning. Students had some control of their learning. They were encouraged constantly to deeply critique the literature and this resulted in question and answer sessions within groups that often lead to either increased or newly constructed knowledge within the group.

Summary of general discussion on engagement. In summary, all of the courses utilized small groups in some fashion or other and students exhibited

different levels of engagement but were nearly always engaged in one of three active levels: interactive, constructive or active. Although architecture and seating were quite different, active student engagement occurred within small groups in each of the classes. Classes that had less complex materials generally had lower levels of engagement in their groups. Instructor interaction, while often necessary, generally reduced engagement levels within groups. The degree that students are allowed to self-determine and control their learning may improve engagement in groups as illustrated by the Greenhouse Management project.

Flipped Learning Instructional Pedagogy Models

Much of the information for this section is found in Appendices N and O. Each instructor used some form of a FLIP model. Each instructor had their own unique model. Not only did models differ but so did their pre-class activities, their definition of a FLIP, their reasons for using it, and their measures of success.

In Basic Calculus (M125) all of the course material was available online in the form of videos making it a total FLIP. This is the approach that is commonly thought of when people hear about the concept today. The advantages of this approach are that students can receive information in both visual and audio formats and have the ability to play back the information at will. Students can easily review materials by pausing, rewinding or forwarding the videos on their cellphones or other media players. It is a great advantage for an instructor that has 675 students and 23 sections to not have to lecture that many times. On the other hand all of the rest of the instructors utilized partial FLIP models. In these

models pre-class instructional materials were in other forms and formats: some videos, readings, grammar tables, and PowerPoints on BlackBoard found online.

The reasons for utilizing FLIP models varied in the pre-observational interviews: to get students more engaged, used to working in groups for future employment opportunities, to have peer-to-peer interaction, to learn to articulate thoughts, to build confidence, and to discuss material together. And the reasons for utilizing FLIP models varied in the post-observational interviews though learning was stressed more: to increase student success, push to deeper learning, for engagement in real world applications, for better retention of subject matter.

Definitions for a FLIP model also differed. These can be viewed in the post-observational interview summary in Appendix O. A sample of definitions are below and note, neither mention videos. A FLIP model is:

Instructor from PS430

> Challenging students to take the initiative to read and/or watch pertinent content related to intended learning goals needed in order to achieve a given level of expertise in the subject matter; then serving as a monitor and resource coach to assure that they can use that information to solve relevant problems related to the intended learning goals rather than lecturing on the content and then asking questions from the lecture material on exams.

Instructor from M125

> Lecture and notes done outside of class; problems and active learning are done in class.

Finally, measures of success using a FLIP model differed. Appendix O illustrates quite a few of these. Some measures voiced by instructors: students engage, students take responsibility for what they do, students negotiate meaning together (this is an exact description of a behavior denoting the interactive level of engagement), students are not passive leading to active discussion, students utilize hands-on activities, students integrate knowledge, students like the videos.

Not a great deal was mentioned about how to improve engagement except from the instructor again from PS430 with,

> Next time I will require more pre-class background reading and/or videos and I will also give clear expected outcomes for each group meeting. This time I wanted to see what subjects and how much project progress the groups would make given only general objectives for the project meetings.
>
> > I wanted to see how much creative thinking came out of the group events. I feel there was a lot of creativity in the groups this year but focus and follow up could be improved

with more specific expected outcomes for each meeting rather than letting them set the pace for how fast they moved through the project goals.

Conclusion

This study examined college student engagement patterns during small-group learning activities. The study was conducted specifically in courses that utilized some form of a flipped learning instructional pedagogy because: (a) there was a paucity of research on student engagement in courses that utilized the pedagogy; (b) the literature implies that engagement occurs in small groups and small groups are purported to be used with the in-class portion of this pedagogy to a higher degree than in the lecture classroom; (c) the pedagogy is increasingly popular with a major reason given as an increase in student engagement, and; (d) engagement is purported to lead to higher learning. For these reasons, student engagement patterns were examined in courses that utilized a FLIP model of some sort.

While it is rational to imply that group activities would increase engagement there was a need to investigate student engagement in the natural setting of the classroom with direct observation techniques. The majority of FLIP and student engagement studies have relied on self-report surveys. A need was seen to conduct a study that was more direct to examine student engagement. Recent studies and reviews on student engagement have called for more direct

classroom observations in the future and for less reliance on self-report survey instruments (Azevedo, 2015; Boekaerts, 2016; Hora, 2015). Hora (2015) noted specifically the need for fine-grained studies of student engagement. He has implemented studies similar to this study in lecture classroom settings and has developed an instrument similar to the CLOSE SCALE instrument developed for this study.

Student engagement is defined in a number of widely varying ways. Student engagement is often depicted in coarse-grained ways unattached to learning activities. An instrument was developed in this study to specifically measure fine-grained student engagement in small-group settings. This instrument was made through a combination of an engagement framework, an activity inventory, and by adding instructor activities along with their complexity levels. The instrument was found to be robust, easy to learn, easy to train, easy to implement and with high inter-rater reliability.

The CLOSE SCALE instrument was used to answer four major questions. The results indicated that all FLIP model classrooms in the study had active levels of engagement that were influenced by both small-group size and the level of activity complexity. Small-group activities were utilized for approximately half of the observed class times. Instructor estimates of small-group engagement showed significant though mild positive correlation with complexity moments calculated from direct observation. All of the above results show that for this study student engagement was increased over normally reported levels during

lectures. Small-group learning activities, as implied, did result in high engagement when measured with a fine-grained tool.

While these results are encouraging, the reader should keep in mind that the study was limited by several factors. These limitations and delimitations are mentioned in the introduction but some are mentioned here. Generalizations cannot be extracted from this study to the larger world because the study only gives a snapshot of engaged behaviors that occurred within selected courses on selected days. Generalizations cannot even be made for a particular classroom for a particular day. The reason for this is that only a few groups were selected for a particular class on a particular day.

The study was limited by time and by the number of observers available. Geography courses, for example, often had 11 groups but only two groups were observed per activity on any day. The Basic Calculus course had 675 students in 23 sections yet this study only observed one section and a maximum of two of five groups on any particular day. The study was very limited in this regard. To summarize, this study provides a series of snapshots of eight courses that indicate high levels of student engagement in small-group learning activities measured by the CLOSE SCALE instrument but does not provide a complete picture even of any one course for the semester or even the day. Several suggestions are given below for potential studies of student engagement during learning activities.

Directions for Future Research

Studies on student engagement are seen as a strong need presently (Boekaerts, 2016). Problems with definition plague engagement studies as with definitions of active learning and FLIP mentioned earlier in this paper (Azevedo, 2015; Boekaerts, 2016; Chi & Wylie, 2014; Hora, 2015). Boekaerts (2016), in a recent commentary, strongly expresses the need for a formal standard definition of student engagement and for rigorous observational studies based on a standardized definition. She even opines that, “the study of engagement would greatly profit from the formation of an international task force”. Azevedo (2015) illustrates the problem of definition with this long quote.

> Engagement is one of the most widely misused and overgeneralized constructs found in the educational, learning, instructional, and psychological sciences. A recent search of the literature on PsycINFO yielded more than 32,000 articles about engagement in the last 14 years. Engagement has been used to describe everything including student academic performance and achievement; classroom behaviors; approaches to interacting with instructional materials; students’ self-perceptions of beliefs in handling individual and contextual aspects of learning situations; students’ enactment of cognitive, motivational, affective, metacognitive, and social processes,

> particularly in academic contexts (e.g., classrooms, intelligent tutoring systems); teacher practices in learner-centered classrooms; and features of instructional and learning contexts designed to initiate, sustain, and foster learning. (Azevedo, 2015, p. 84)

Future studies could benefit in a number of ways. With the following suggestions an addition is the use of the designed CLOSE SCALE instrument from this study. One way to achieve a clearer picture would be to do the same type of study found here but with several more observers. Using six observers instead of two would have improved this study. Another possibility would be to observe student engagement in small groups as a whole rather than individually. For example: four 1-2 minute intervals of observing and rapidly moving on to another group. With this method observers could cover more groups in the same activity.

Observational studies on student engagement should compare both FLIP and non-FLIP classes that incorporate active learning in small groups.

This study has illustrated the potential influence of instructors on student engagement in the classroom. A study similar to this study using the CLOSE SCALE observational tool could investigate the effect of instructors on the engagement modes of students. The TAs' and instructors' approaches in all sections of a course could be observed and compared. This comparison should

correlate the TA's and instructor's estimates of engagement to the calculated complexity moments of the observers. A course such as the Calculus course mentioned in this study, with 13 TAs and 23 sections, would be a perfect subject for such an investigation. This could serve the dual purpose of arriving at a larger picture of the complete course and of describing the influence of different TAs on student engagement. Observational studies of this sort can bring needed clarity to student engagement patterns in small groups.

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Appendices

Appendix A: The Active Learning Inventory Tool © 2006

Complexity Level[1*]	Code	Activity Description[2,3]
Low Complexity	A*	*Question & Answer*: Students orally respond to a question, comment, etc either ***voluntarily*** or by ***cold-calling.*** ****A1 and A2 denote simple knowledge / comprehension questions (recall) and generally are asked by instructor but limited or no time is provide for the student to process / respond. A1 denotes students responded to question / A2 denotes students were asked to respond AND given time but did not respond – will track A1 and A2 for numbers but not time as conducted in less than 1 minute. A3 denote a higher-order question, where students are provided time (>1 min) to process then respond. This does not include rhetorical questions.***
	B	*One-minute paper / Focused Listing / One Sentence Summary*: Short writing task designed to allow students to focus attention on a single important term, name or concept from a particular lesson / session
	C	*Think/Pair/Share*: Short, individual written response to a prompt/question; ***then*** instructed to share and discuss briefly with partner; ***then*** asked to share with larger group
	D	*Brain Dump / Free Write*: Short write in which students write down everything they know about an announced topic.
	E	*Muddiest Point*: At some point during or after an in-class presentation, students write a quick response to the prompt, "What was the muddiest point in _____?"
	F	*Misconception / Preconception Check*: Simple technique for gathering information on what students perceive they already know
	G	*Application Activity*: Written activity in which students apply 1-2 principles and concepts to real life situation
	H	*Student-Generated Questions*: Students create questions for quizzes or exams that are crafted to capture central elements of the course
	I	*Formative Quizzes / Surveys (Background Knowledge Probe)*: Ungraded quizzes / surveys to determine comprehension
	J	*Computer Based Interaction Systems: (Personal response system)* Students participate in the lecture by responding to questions / statements via computers / wireless technology.
	K	*Self / Peer Formative Assessment*: Activities that require students to assess performance against applicable criteria; extend to offer specific suggestions for improvement
Moderate Complexity	L	*Small Group Presentations / Discussions*: Presentations / discussions of course material – led by ❑ ***Faculty*** vs. ❑ ***Student***
	M	*Role Playing / Simulations / Games*: Students and/or faculty performing specific roles for demonstration purposes Simulations / games include guiding principles, specific rules and structured relationships
	N	*Categorizing Grid / Pro-Con Grid*: Students are presented with 2-3 important categories (superordinate concepts) along with a scrambled subordinate terms, images, equations or other items that belong in one or another of the superordinate categories.
	O	*Defining Features Matrix / Memory Matrix*: Students categorize concepts presented according to presence (+) / absence (-) of defining features
	P	*Debates*: Small or large group structured exploration of central concepts, data, beliefs, values
	Q	*Peer Teaching*: Students teaching each other basic and/or intermediate levels of course materials or needed skills
	R	*Concept Maps*: Drawings or diagrams that show the mental connections that students make between a major concept presented and other concepts they have learned
High Complexity	S	*Cases*: Scenarios that require students to integrate their skills to solve problems that relate to course material
	T	*Cooperative Cases*: Scenario-based problem-solving activity using small groups to tackle specific questions/issues from larger list
	U	Jigsaw: Team-based: each member becomes subject matter expert in 1 of 4 areas selected from current course material. Each member teaches their subject matter.
	V	*Cooperative Learning / Problem Based Learning*: Students work together to learn course knowledge and to develop course skills.

Faculty gender: ❑ Male ❑ Female

Years of Teaching:
❑ 0-1 ❑ 2-5 ❑ 6-10 ❑ 11-15 ❑ 16-20 ❑ >20

Time of day: ❑ 8-12:59pm ❑ 1-4:59pm ❑ After 5pm

Age Range: ❑ 25-29 ❑ 30-34 ❑ 35-39 ❑ 40-44 ❑ 45-49 ❑ 50-54 ❑ 55-59 ❑ 60+

Course: ❑ Undergraduate ❑ Graduate

Number of Students: _____

❑ Non-tenure ❑ Tenure
❑ Assistant ❑ Associate ❑ Full Professor

Discipline: _____

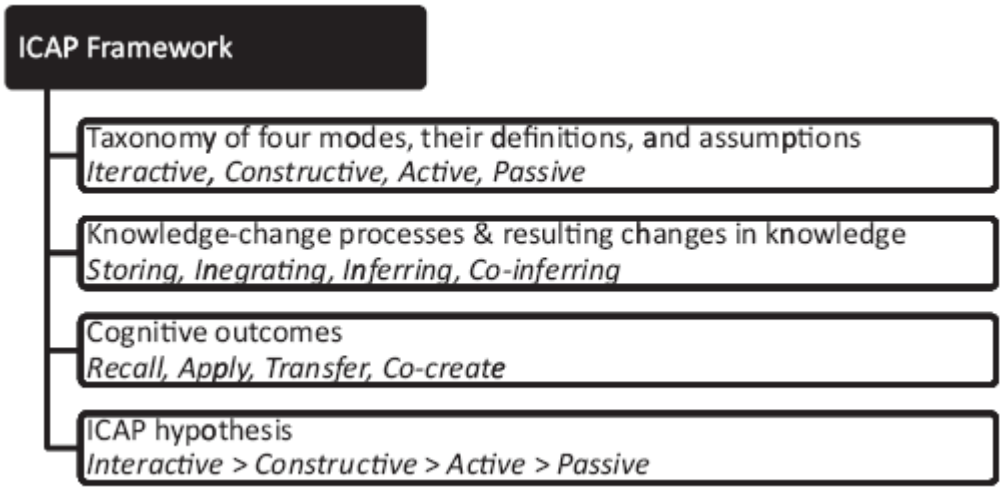
Type / Location of Room: _____

Question & Answer *(Total – from table)*	A_1:			A_2:				A_3:		
	AL Episode 1	AL Episode 2	AL Episode 3	AL Episode 4	AL Episode 5	AL Episode 6	AL Episode 7	AL Episode 8	AL Episode 9	AL Episode 10
Code										
Activity Description										
Complexity										
Time start										
Time end										
Total time (minutes)										

AL Quantitative Summary		**Reviewer Response**
Item I: Total # times AL used:		**Please provide specific feedback on the following:** **(1) Faculty approach in activity** **(2) Quality of classroom environment during the activity** **(3) Overall atmosphere**
Item II: # Different types of AL used:		
Item III: # Low complexity / total:		
Item IV: # Moderate complexity / total:		
Item V: # High complexity / total:		
Item VI: Total time spent for all AL activities: ***(sum total time for all activities)***		
Item VII: Average time per AL activity: ***(total time/ total # times AL used)***		

From "A Tool for Measuring Active Learning in the Classroom," by Jenny A. Van Amburgh, John W. Devlin, Jennifer L. Kirwin, and Donna M. Qualters, 2007, American Journal of Pharmaceutical Education, 71, pp. 7-8. Copyright 2007 by American Association of Colleges of Pharmacy. Reprinted with permission of Jenny A. Van Amburgh.

Appendix B: ICAP Framework with Examples of Learning Activities



Examples of Learning Activities by Mode of Engagement

	PASSIVE *Receiving*	ACTIVE *Manipulating*	CONSTRUCTIVE *Generating*	INTERACTIVE *Dialoguing*
LISTENING to a lecture	Listening without doing anything else but oriented toward instruction	Repeating or rehearsing; Copying solution steps; Taking verbatim notes	Reflecting out-loud; Drawing concept maps; Asking questions	Defending and arguing a position in dyads or small group
READING a text	Reading entire text passages silently/aloud without doing anything else	Underlining or highlighting; Summarizing by copy-and-delete	Self-explaining; Integrating across texts; Taking notes in one's own words	Asking and answering comprehension questions with a partner
OBSERVING a video	Watching the video without doing anything else	Manipulating the tape by pausing, playing, fast-forward, rewind	Explaining concepts in the video; Comparing and contrasting to prior knowledge or other materials	Debating with a peer about the justifications; Discussing similarities & differences

From "The ICAP Framework: Linking Cognitive Engagement to Active Learning Outcomes," by Michelene T. H. Chi & Ruth Wylie, 2014, *Educational Psychologist, 49:4*, p. 221. Copyright 2014 by the American Psychological Association.

Appendix C: Group Activities Added to SCALE

Complexity Level	Code	Activity Description
low	CDS	Cards set in order in by a group to establish proper Mathematical ordering for problem-solving
Moderate to high	CQ	Collaborative quiz, students work in groups together to answer quiz questions
	GP	Students work together in groups on semester long project
Moderate	GPS	Students work together in groups to solve mathematics problems
Moderate	GW	Students work together in groups to complete grammar worksheets
Moderate	PN	Students work together in groups to “ponder” difficult research problems and arrive at alternative solutions
Moderate	RG	Students work together in groups and as a relay team compete with other groups in mathematical problem-solving
High	TA	Students work together in groups to analyze texts in language literature

Appendix D: Overt Student Engagement Behaviors

Overt Student Behaviors (ICAP framework)

4	3	2	1	0 (off task)
Interactive(4)	Constructive(3)	Active(2)	Passive(1)	Off-Task(0)
Asking and answering comprehension questions	Asking Questions	Copying	Listening	Eyes wandering
Asking and answering questions with partner	Comparing and contrasting cases	Gesturing	Reading	Playing with other electronic devices
Debating with peer about justifications	Comparing and contrasting to prior knowledge or other materials	Highlighting	Watching	Playing with smartphone
Defending and arguing	Constructing Timelines	Looking		Talking off-subject
Defending and arguing a position	Drawing analogies	Pointing		
Discussing similarities and differences	Drawing concept maps	Rehearsing		
Must interact constructively	Explaining concepts in video	Repeating		
Teaching another student	Integrating text and diagrams	Rotating objects		
	Making plans	Searching		
	Production of new outputs	Selecting		
	Provide Justification	Summarizing by copy and delete		
	Reflecting and monitoring ones' own understanding	Taking verbatim notes		
	Reflecting out-loud	Underlining		
	Self-explaining			
	Taking notes in own words			

Adapted from : Chi & Wylie, 2014; Chi, 2011

Appendix E: The CLOSE SCALE Observation Instrument Checklist

Observation Checklist for Student-Centered Active Learning
Exercise (SCALE) and Complexity Level of Overt Student Engagement (CLOSE)

Course_____	Date _____	Total student number _____
Class time _____		Number of small groups _____

Student-Centered Active Learning Exercise (SCALE)

Observer No. ____		Small group number _____
Activity Code_____		Start Time _____
Activity Name _____		End Time _____
Activity Complexity: High Medium Low		

Observational notes on SCALE should try to include:
1) Instructor approach in exercise
2) Quality of classroom environment during the activity
3) Overall atmosphere

SCALE notes

		Complexity Level of Overt Student Engagement (CLOSE)*					
		On Task				Off Task	Notes on engagement
Student	Sex	4 - Interactive	3 - Constructive	2 - Active	1 - Passive	0 - Off Task	
1	M F						
2	M F						
3	M F						
4	M F						
5	M F						
6	M F						
7	M F						
8	M F						
9	M F						
10	M F						
11	M F						
12	M F						
Total							
Weighted Score**							

*A tally signifies the highest level of engagement reached during a one minute observation interval.
**A weighted score is determined multiplying the sum of each column by its assigned number value.

Additional observational notes on SCALE and/or CLOSE

Instructor estimate of group's activity: 0 = off-task, disengaged; 4 = fully engaged = 0 1 2 3 4

Estimate of class activity: 0 = off-task, disengaged; 4 = fully engaged = 0 1 2 3 4

Adapted from the *Active Learning Inventory Tool* © 2006 and the ICAP Framework (M Chi & Wylie, 2014; Van Amburgh et al., 2007).

Appendix F: Institutional Review Board Approval Letter

THE UNIVERSITY of TENNESSEE
KNOXVILLE
Office of Research & Engagement
INSTITUTIONAL REVIEW BOARD (IRB)

1534 White Ave.
Knoxville, TN 37996-1529
865-974-7697
fax 865-974-7400

December 07, 2015

John C Cummins,
UTK - Educational Psychology & Counseling

Re: UTK IRB-15-02542-XP
Study Title: College Student Engagement Patterns in Small Group Learning Activities Conducted in Courses Organized using a Flipped Learning Instructional Pedagogy

Dear Mr. Cummins:

The Administrative Section of the UTK Institutional Review Board (IRB) reviewed your **application** for the above referenced project. It determined that your application is eligible for **expedited** review under 45 CFR 46.110(b)(1), Category 7. The IRB has reviewed these materials and determined that they do comply with proper consideration for the rights and welfare of human subjects and the regulatory requirements for the protection of human subjects.

Therefore, this letter constitutes full approval by the IRB of your application (version 1.5) as submitted, including version 1.0 of the three data collection instruments, and version 1.2 of the instructor/student consent form which has been dated and stamped IRB approved. Approval of this study will be valid from 12/07/2015 to 12/06/2016.

In the event that subjects are to be recruited using solicitation materials, such as brochures, posters, web-based advertisements, etc., these materials must receive prior approval of the IRB. Any revisions in the approved application must also be submitted to and approved by the IRB prior to implementation. In addition, you are responsible for reporting any unanticipated serious adverse events or other problems involving risks to subjects or others in the manner required by the local IRB policy.

Finally, **re-approval** of your project is required by the IRB in accord with the conditions specified above. You may not continue the research study beyond the time or other limits specified unless you obtain prior written approval of the IRB.

Sincerely,

Colleen P. Gilrane

Colleen P. Gilrane, Ph.D.
Chair

Appendix G: Informed Consent Statements

Informed Consent Statement for Instructors

Student Engagement in Small-group Active Learning Situations with a Flipped Learning Instructional Pedagogy

INTRODUCTION
This is an observational research study. The purpose of this study is to research student engagement in active learning. There is increased interest at UTK to develop courses that involve more hands-on, interactive activities and group-based learning, instead of the traditional lecture format. Of particular interest is student engaged learning in small groups in these activities. The ultimate goal is to increase students' problem-solving abilities and critical thinking skills that will help them succeed in this and future classes.

INFORMATION ABOUT YOUR INVOLVEMENT IN THE STUDY
The information that will be needed from you will be in the form of an initial interview where you will be asked several questions about your class. In addition after each observation activity you will be asked to rate activity levels of student behaviors. I would like to conduct a final interview with you at the end of the semester. Your participation is voluntary and you can withdraw from the study at any time.

RISKS
This research involves minimal risk to you which means that risks associated with your participation in this study are no greater than those encountered in daily life. All data collected from you during interviews and the signed informed consent statement (this form) will contain personally identifiable information. This means that any possible breach of confidentiality would result in your being identified as having agreed to participate in the study and with your responses to the interview questions. Every effort will be made to prevent any unauthorized access to your data during the term of the research project.
All of the data collected as part of this research project will be stored as described below in the confidentiality section.

BENEFITS
There will be no direct benefit to you from the results of this study. Although you might not directly benefit from the results of this study, the information will be used to support the development of more active-learning type classes and classrooms at UTK. The research gathered will be used to support engagement research in general by increasing the overall body of knowledge in that field.
_____ Instructor's initials

CONFIDENTIALITY
All participant data will be kept confidential. All study data will be stored in a secure, locked cabinet in the researcher's office. Any electronic data analyses or summaries will be password protected. All consent forms will also be stored in a secure cabinet and kept on file for the required 3 years after the formal closure of the study, at which point they will be destroyed in accordance with IRB requirements. No references will be made in oral or written reports that could identify individual instructors with any review responses.

CONTACT INFORMATION
If you have questions at any time about the study or the procedures, (or you experience adverse effects as a result of participating in this study,) you may contact the researcher, John Cummins, at 256b Plant Biotechnology, and office number 865.974.4457 or cell number 865.228.9789. If you have questions about your rights as a participant, contact the Office of Research Compliance Officer at (865) 974-7697.

PARTICIPATION
Your participation in this study is voluntary; you may decline to participate without penalty or loss of benefits to which you are otherwise entitled. If you decide to participate, you may withdraw from the study at any time without penalty and without loss of benefits to which you are otherwise entitled.

CONSENT
I have read the above information. I have received a copy of this form. I agree to participate in this study.
Instructor's name (printed) _____
Instructor's signature _____ Date _____
Investigator's signature _____ Date _____

Informed Consent Statement for Students

Observation of Small-group Active Learning Situations

INTRODUCTION
The purpose of this research study is to observe active learning in your classroom. There is increased interest at UTK to develop courses that involve more hands-on, interactive activities and group-based learning, instead of the traditional lecture format. We hope through observation to provide feedback to your instructors concerning active learning during these activities. While our ultimate goal is to see an increase in students' problem-solving abilities and critical thinking skills it is not expected that you will receive any direct benefits from this study. We will be observing some of your small-group sessions during the semester.

INFORMATION ABOUT YOUR INVOLVEMENT IN THE STUDY
We will be observing your learning in small groups by getting as close as possible to the activities with a minimum disturbance to you. When a small-group activity starts we will rapidly map out the classroom and start observations of two small groups in your class. We will do as many separate observations per class as there are group activities and plan to do up to four observations per class per semester. You will not be audio or video taped. Your participation is entirely voluntary and you may withdraw from the study at any time and this will have no effect on your grades. Because of the random nature of the study you may or may not be observed in the study, only two active groups will be observed during an activity.

RISKS This research involves minimal risk which means that risks associated with your participation in this study are no greater than those encountered in daily life. All data collected from you will be anonymous with the exception of your signed informed consent statement (this form). This means that any possible breach of confidentiality would result only in your being identified as having agreed to participate in the study. Again, there will be no identifiers linking your name to any of the data collected. One purpose of the study is to examine group behaviors and these are determined by aggregating the individual behaviors of all group members. The identities of specific individual group members will not be recorded. All of the data collected as part of this research project will be stored as described below in the confidentiality section.

BENEFITS There will be no direct benefit to you from the results of this study. Though you will not directly benefit from the results of this study, the information will be used to support the development of more active-learning type classes and classrooms at UTK. The research gathered will be used to support student learning in general by increasing the overall body of knowledge in the field.

_____ Participant's initials

CONFIDENTIALITY
All participant data will be kept confidential. Neither your names nor any identifying information will be associated with the data collected from group observations. All study data will be stored in a secure, locked cabinet in the researcher's office. Any electronic data analyses or summaries will be password protected. All consent forms will also be stored in a secure cabinet and kept on file for the required 3 years after the formal closure of the study, at which point they will be destroyed in accordance with IRB requirements. No references will be made in oral or written reports that could identify individual participants with any group observations.

CONTACT INFORMATION If you have questions at any time about the study or the procedures, (or you experience adverse effects as a result of participating in this study,) you may contact the researcher, John Cummins, at 256b Plant Biotechnology, and office number 865.974.4457 or cell number 865.228.9789. If you have questions about your rights as a participant, contact the Office of Research Compliance Officer at (865) 974-7697. **PARTICIPATION** Your participation in this study is voluntary; you may decline to participate without penalty or loss of benefits to which you are entitled. If you decide to participate, you may withdraw from the study at any time without penalty and without loss of benefits to which you are otherwise entitled.

CONSENT
I have read the above information. I have received a copy of this form. I agree to participate in this study.
Participant's name (printed) _____
Participant's signature _____ Date _____
Investigator's signature _____ Date _____

Appendix H: Pre-observational Instructor Interview Questions

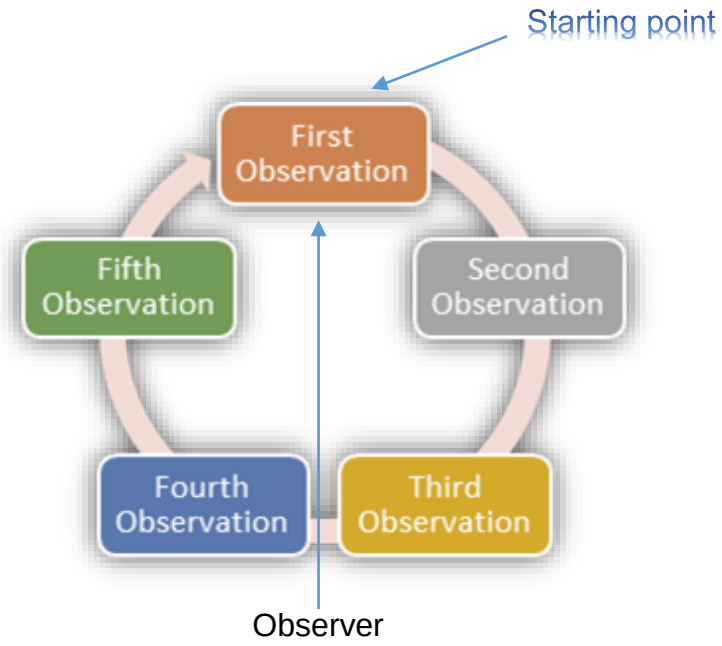
1. How many years have you been teaching?
2. What is/are the course(s) you are teaching?
3. How many semesters have you used a Flipped Learning Instructional Pedagogy?
4. Would you describe your classroom situation as a partial flip or complete flip?
5. How often do you use small groups?
6. Do you use them in every class?
7. Why do you use a Flipped Learning Instructional Pedagogy?
8. Can you characterize the pre-class materials that the students must complete before coming to class?
9. What are the typical materials they would be required to complete?
10. Do they take quizzes before coming to class?
11. Anything you would like to add about the pre-class activities?
12. What will students typically do upon arriving in the classroom?
13. What is the minimum number of small-group breakout sessions in a typical class? The maximum?
14. Why do you have students break up into smaller groups?

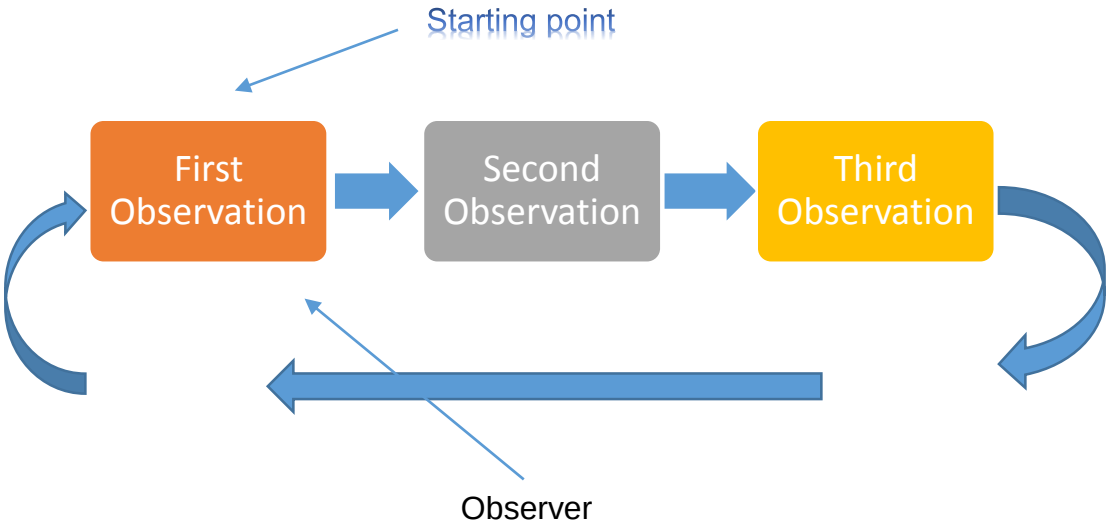
Appendix I: Post-observational Instructor Interview Questions

1. On a scale of zero to four with four being the highest level of engagement and zero being non-engaged and off-task, how engaged do you feel your students were in the group activities during the semester as a whole?
2. What might you do differently to increase engagement?
3. What proportion of class time are students typically involved in active small groups?
4. What proportion of the time that students were in small groups do you think they were actively engaged?
5. In what ways do you think a Flipped Learning Instructional Pedagogy was successful?
6. Will you use it again?
7. Are there small-group learning activities that you would eliminate in the future?
8. Are there any you would add?
9. What is your present definition of a Flipped Learning Instructional Pedagogy?
10. Why do you use it?

Appendix J: Observational Direction of Small Groups

Observations will start with the student directly opposite the observer and continue in a clockwise fashion until the SCALE is finished. If students are aligned in a horizontal fashion, observations will start with the student on the left.





Appendix K: Observational Raw Data with Minimum Instructor Interaction

		Class and Group Demographics									ICAP Engagement (minutes in level)					SCALE					
Observer	Class	Date	Class Size	Class Time	Group Time	Groups	Group No.	Group Size	M	F	Interactive	Constructive	Active	Passive	Off-Task	Level	Code*	Group Estimate	Class Estimate	Comp. Mom	Avg. Comp Moment
1	G345	1252016	40	50	16.0	8	8	4	2	2	1.0	8	6	1	0	moderate	SGD	3.0	3.0	2.5	NA
1	G345	1252016	40	50	7.0	4	3	12	3	9	0.0	2	5	0	0	low	Q&A	4.0	3.0	2.2	NA
2	G345	1292016	40	50	10.0	12	4	3	2	1	4.0	2	4	0	0	moderate	SGD	4.0	3.0	3	NA
1	G345	2032016	39	50	12.0	11	1	4	1	3	3.0	5	4	0	0	moderate	SGD	3.0	3.5	2.9	NA
1	G345	2052016	39	50	10.0	11	11	3	1	2	3.0	5	2	0	0	moderate	SGD	3.0	3.0	3.1	NA
1	G345	2052016	39	50	21.0	11	2	4	2	2	11.0	1	9	0	0	high	CQ	3.5	4.0	3.1	NA
1	G345	2102016	40	50	17.0	11	6	4	2	2	6.0	7	2	2	0	moderate	SGD	4.0	3.0	3	NA
1	G345	2192016	37	50	12.0	11	11	3	2	1	2.0	2	8	0	0	moderate	CQ	1.0	2.5	2.5	NA
1,2	G436	1192016	41	75	2.0	20	6	2	0	2	1.0	1	0	0	0	low	TPS		1.0	3.5	3.5
1	G436	1192016	41	75	6.0	11	4	4	2	2	0.0	2	4	0	0	moderate	SGD		3.0	2.3	2.4
2	G436	1192016	41	75	6.0	11	1	4	2	2	2.0	1	1	2	0	moderate	SGD		3.0	2.5	NA
1	G436	1262016	39	75	10.0	10	4	4	3	1	3.0	5	2	0	0	high	CS	3.0	3.0	3.1	NA
1	G436	1282016	42	75	29.0	11	9	4	2	2	5.0	3	19	1	1	moderate	CQ	3.0	3.0	2.3	NA
1	G436	2112016	38	75	26.0	11	8	4	3	1	12.0	6	7	1	0	high	CQ	3.0	3.5	3.1	3.1
2	G436	2112016	38	75	28.0	11	2	4	2	2	12.0	8	7	1	0	high	CQ	3.5	**3.5**	3.1	NA
1	G436	2252016	41	75	19.0	11	11	4	2	2	10.0	2	7	0	0	moderate	CQ	3.0	3.0	2.8	NA
1	M125	1252016	25	50	8.0	5	3	5	3	2	0.0	3	2	3	0	moderate	RG	3.0	3.0	2	NA
1	M125	1252016	25	50	6.0	5	2	5	3	2	0.0	0	6	0	0	moderate	GPS	2.0	2.0	2	NA
2	M125	2012016	24	50	14.0	5	5	5	2	3	2.0	4	7	1	0	moderate	GPS	3.5	3.0	2.5	2.7
1	M125	2012016	24	50	13.0	5	4	5	3	2	4.0	3	6	0	0	moderate	GPS	3.5	3.0	2.8	NA
1	M125	2102016	23	50	13.0	5	5	4	2	2	4.0	4	5	0	0	low	CDS	2.0	3.0	2.9	2.8
2	M125	2102016	23	50	15.0	5	1	5	4	1	3.0	4	7	1	0	low	CDS	2.0	3.0	2.6	NA
1	M125	2242016	25	50	23.0	5	5	5	2	3	1.0	9	13	0	0	moderate	WS	1.0	**2.5**	2.4	NA
1	M125	3092016	23	50	6.0	5	1	5	2	3	3.0	1	2	0	0	moderate	TPS	1.5	2.0	3.1	NA
1	M125	3092016	23	50	3.0	11	1	3	3	0	2.0	1	0	0	0	moderate	TPS	2.5	2.0	3.6	NA
2	PS331	2172016	12	50	10.0	4	4	4	4	0	3.0	1	5	1	0	moderate	PN	2.0	3.0	2.6	2.6
1	PS331	2172016	12	50	9.0	4	3	4	2	2	2.0	4	1	2	0	moderate	PN	3.0	3.0	2.6	NA
2	PS331	2242016	12	50	14.0	4	3	2	0	2	4.0	5	5	0	0	moderate	PN	3.0	3.0	2.9	3
1	PS331	2242016	12	50	15.0	4	1	4	4	0	7.0	5	3	0	1	moderate	PN	2.0	3.0	3	NA
2	PS430	2112016	31	75	19.0	7	6	5	1	4	11.0	7	1	0	0	high	GP	3.6	**3.5**	3.5	3.7
1	PS430	2112016	31	75	36.0	7	7	6	4	2	34.0	1	1	0	0	high	GP	3.8	3.5	3.9	NA
1	PS430	2252016	31	75	9.0	6	4	4	4	0	8.0	0	1	0	0	high	GP	3.5	3.9	3.7	3.6
2	PS430	2252016	31	75	12.0	6	3	4	4	0	9.0	2	1	0	0	high	GP	3.5	3.9	3.6	NA
1	PS430	2252016	31	75	12.0	6	6	6	2	4	10.0	1	1	0	0	high	GP	3.7	3.9	3.7	NA
1	PS430	2252016	31	75	15.0	6	5	6	4	2	9.0	4	2	0	0	high	GP	3.7	3.9	3.5	NA
2	PS430	2252016	31	75	14.0	6	1	7	5	2	9.0	2	3	0	0	high	GP	3.5	3.9	3.4	NA

		Class and Group Demographics									ICAP Engagement (minutes in level)					SCALE					
Observer	Class	Date	Class Size	Class Time	Group Time	Groups	Group No.	Group Size	M	F	Interactive	Constructive	Active	Passive	Off-Task	Level	Code*	Group Estimate	Class Estimate	Comp. Mom	Avg. Comp Moment
1	PS430	3102016	13	75	9.0	5	2	3	3	0	6.0	2	1	0	0	high	GP	3.9	3.8	3.5	3.5
1	PS430	3102016	13	75	16.0	5	3	3	2	1	13.0	1	1	0	1	high	GP	3.7	3.8	3.5	NA
1	PS438538	2252016	9	75	18.0	3	3	3	3	0	12.0	1	4	0	1	moderate	PN	3.0	3.0	3.2	2.7
2	PS438538	2252016	9	75	13.0	3	2	3	3	0	0.0	4	8	0	1	moderate	PN	4.0	3.0	2.1	NA
1	S300	1292016	11	50	25.0	5	4	2	1	1	20.0	2	3	0	0	moderate	GW	2.0	4.0	3.6	NA
2	S300	2012016	11	50	15.0	5	2	2	0	2	1.0	12	2	0	0	moderate	GW	4.0	3.0	2.9	3
1	S300	2012016	11	50	11.0	5	3	2	0	2	4.0	3	4	0	0	moderate	GW	4.0	3.0	3	NA
2	S300	2052016	10	50	17.0	5	1	2	1	1	5.0	9	1	2	0	moderate	GW	1.0	3.0	3	NA
1	S300	2082016	12	50	16.0	6	2	2	0	2	8.0	7	0	1	0	moderate	GW	4.0	4.0	3.3	NA
1	S300	2102016	11	50	17.0	5	6	2	1	1	10.0	6	1	0	0	moderate	GW	4.0	4.0	3.5	NA
1	S300	2222016	12	50	20.0	4	1	3	1	2	15.0	3	2	0	0	moderate	GW	3.0	3.0	3.6	NA
1,2	S300	2242016	11	50	16.5	4	3	3	1	2	11.5	3	2	0	0	moderate	GW	3.5	**3.0**	3.6	3.6
1	S330	1272016	18	50	18.0	9	2	2	2	0	15.0	3	0	0	0	high	TA	4.0	2.8	3.8	NA
2	S330	1292016	19	50	14.0	9	2	2	2	0	5.0	6	3	0	0	high	TA	4.0	3.5	3.1	3.4
1	S330	1292016	19	50	15.0	9	7	2	0	2	11.0	4	0	0	0	high	TA	4.0	3.5	3.7	NA
2	S330	2012016	15	50	13.0	7	7	2	1	1	5.0	6	2	0	0	high	TA	3.7	2.7	3.2	3.4
1	S330	2012016	15	50	16.0	7	6	2	0	2	12.0	2	2	0	0	high	TA	4.0	2.7	3.6	NA
1	S330	2032016	17	50	14.0	8	8	3	1	2	6.0	2	5	1	0	high	TA	3.8	**4.0**	2.9	NA
2	S330	2052016	18	50	15.0	8	6	2	0	2	10.0	3	2	0	0	high	TA	3.0	4.0	3.5	NA
1	S330	2052016	18	50	13.0	8	3	2	1	1	11.0	2	0	0	0	high	TA	3.8	4.0	3.8	3.7
1	S330	2082016	17	50	15.0	9	6	3	3	0	11.0	3	1	2	0	high	TA	4.0	4.0	3.3	NA
2	S330	2102016	16	50	18.0	8	5	2	2	0	11.0	6	1	0	0	high	TA	4.0	4.0	3.5	NA
1	S330	2102016	16	50	17.0	8	3	2	1	1	17.0	0	0	0	0	high	TA	4.0	4.0	4	3.8

*SCALE Code: CDS = ordering cards, CQ = Collaborative Quiz, CS = Case Study, GP = Group Project, GPS = Group Problem Solve, GW = Grammar Worksheet, PN = Ponderables, Q&A = Question and Answer, RG =Relay Game, SGD = Small Group Discussion, TA = Text Analysis, TPS = Think Pair Share

Appendix L: Observational Raw Data with Instructor Interaction

Class and Group Demographics												ICAP Engagement level (min.)					SCALE		
Obs. No.	Class	Date	Class Size	Class Time	Indv. Group Time	Total Group Time	Groups	Group No.	Group Size	M	F	Interactive	Constructive	Active	Passive	Off-Task	Level	Code*	Comp. Mom
1	G345	1252016	40	50	16.0		8	8	4	2	2	1.0	8	6	1	0	moderate	SGD	2.5
1	G345	1252016	40	50	7.0	23.0	4	3	12	3	9	0.0	2	5	0	0	low	Q&A	2.2
2	G345	1292016	40	50	12.0	12.0	12	4	3	2	1	4.0	2	6	0	0	moderate	SGD	2.8
1	G345	2032016	39	50	12.0	12.0	11	1	4	1	3	3.0	5	4	0	0	moderate	SGD	2.9
1	G345	2052016	39	50	13.0	38.0	11	11	3	1	2	3.0	6	3	1	0	moderate	SGD	2.8
1	G345	2052016	39	50	25.0		11	2	4	2	2	12.0	3	10	0	0	high	CQ	3
1	G345	2102016	40	50	17.0	17.0	11	6	4	2	2	6.0	8	2	3	0	moderate	SGD	2.8
1	G345	2192016	37	50	12.0	12.0	11	11	3	2	1	2.0	2	8	0	0	moderate	CQ	2.5
1,2	G436	1192016	41	75	2.0		20	6	2	0	2	1.0	1	0	0	0	low	TPS	NA
1	G436	1192016	41	75	6.0		11	4	4	2	2	0.0	2	4	0	0	moderate	SGD	NA
2	G436	1192016	41	75	6.0	8.0	11	1	4	2	2	2.0	1	1	2	0	moderate	SGD	NA
1	G436	1262016	39	75	23.0	23.0	10	4	4	3	1	3.0	9	11	0	0	high	CS	2.6
1	G436	1282016	42	75	31.0	31.0	11	9	4	2	2	5.0	3	20	2	1	moderate	CQ	2.2
1	G436	2112016	38	75	29.0	29.0	11	8	4	3	1	14.0	6	7	2	0	high	CQ	3.1
2	G436	2112016	38	75	28.0		11	2	4	2	2	12.0	8	7	1	0	high	CQ	3.1
1,2	G436	2252016	41	75	19.0	19.0	11	11	4	2	2	11.0	1	7	0	0	moderate	CQ	3.2
1	M125	1252016	25	50	8.0		5	3	5	3	2	0.0	3	2	3	0	moderate	RG	2.0
1	M125	1252016	25	50	6.0	14.0	5	2	5	3	2	0.0	0	6	0	0	moderate	GPS	2.0
1	M125	2012016	24	50	14.0		5	5	5	3	2	4.0	4	6	0	0	moderate	GPS	2.8
2	M125	2012016	24	50	20.0	20.0	5	4	5	2	3	2.0	4	7	7	0	moderate	GPS	2.0
1	M125	2102016	23	50	13.0		5	5	4	2	2	4.0	5	5	0	0	low	CDS	2.9
2	M125	2102016	23	50	15.0	15.0	5	1	5	4	1	3.0	4	7	1	0	low	CDS	2.6
1,2	M125	2242016	25	50	25.0	25.0	5	5	5	2	3	1.0	10	13	0	0	moderate	WS	2.4
1	M125	3092016	23	50	6.0	25.0	5	1	5	2	3	3.0	1	2	0	0	moderate	TPS	3.1
1	M125	3092016	23	50	3.0		11	1	3	3	0	2.0	1	0	0	0	moderate	TPS	3.6
2	PS331	2172016	12	50	10.0		4	4	4	4	0	3.0	1	5	1	0	moderate	PN	2.6
1	PS331	2172016	12	50	10.0	10.0	4	3	4	2	2	2.0	5	1	2	0	moderate	PN	2.7
2	PS331	2242016	12	50	15.0		4	3	2	0	2	4.0	6	5	0	0	moderate	PN	2.9
1	PS331	2242016	12	50	20.0	20.0	4	1	4	4	0	7.0	6	4	1	2	moderate	PN	2.7
2	PS430	2112016	31	75	19.0		7	6	5	1	4	11.0	7	1	0	0	high	GP	3.5
1	PS430	2112016	31	75	37.0	37.0	7	7	6	4	2	34.0	1	2	0	0	high	GP	3.8
1	PS430	2252016	31	75	9.0		6	4	4	4	0	8.0	0	1	0	0	high	GP	3.7

	Class and Group Demographics											ICAP Engagement level (min.)					SCALE		
Obs. No.	Class	Date	Class Size	Class Time	Indv. Group Time	Total Group Time	Groups	Group No.	Group Size	M	F	Interactive	Constructive	Active	Passive	Off-Task	Level	Code*	Comp. Mom
2	PS430	2252016	31	75	16.0		6	3	4	4	0	9.0	4	3	0	0	high	GP	3.3
1	PS430	2252016	31	75	12.0		6	6	6	2	4	10.0	1	1	0	0	high	GP	3.7
1	PS430	2252016	31	75	15.0	36.0	6	5	6	4	2	9.0	4	2	0	0	high	GP	3.5
2	PS430	2252016	31	75	14.0		6	1	7	5	2	9.0	2	3	0	0	high	GP	3.4
1	PS430	3102016	13	75	9.0	25.0	5	2	3	3	0	6.0	2	1	0	0	high	GP	3.5
1	PS430	3102016	13	75	16.0		5	3	3	2	1	13.0	1	1	0	2	high	GP	3.3
1	PS438538	2252016	9	75	18.0	18.0	3	3	3	3	0	12.0	4	16	5	1	moderate	PN	2.5
2	PS438538	2252016	9	75	14.0		3	2	3	3	0	0.0	5	8	0	1	moderate	PN	2.2
1	S300	1292016	11	50	48.0	48.0	5	4	2	1	1	20.0	5	23	0	0	moderate	GW	2.9
1	S300	2012016	11	50	24.0	24.0	5	2	2	0	2	4.0	7	13	0	0	moderate	GW	2.6
2	S300	2012016	11	50	15.0		5	3	2	0	2	1.0	12	2	0	0	moderate	GW	2.9
2	S300	2052016	10	50	38.0	38.0	5	1	2	1	1	7.0	11	7	13	0	moderate	GW	2.2
1	S300	2082016	12	50	40.0	40.0	6	2	2	0	2	9.0	11	10	10	0	moderate	GW	2.4
1	S300	2102016	11	50	31.0	31.0	5	6	2	1	1	10.0	6	1	0	0	moderate	GW	2.8
1	S300	2222016	12	50	41.0	41.0	4	1	3	1	2	16.0	8	13	3	1	moderate	GW	2.8
1,2	S300	2242016	11	50	40.5	40.5	4	3	3	1	2	13.5	8	15	4	0	moderate	GW	2.7
1	S330	1272016	18	50	43.0	43.0	9	2	2	2	0	15.0	5	22	1	0	high	TA	2.7
1	S330	1292016	19	50	49.0	49.0	9	2	2	0	2	11.0	5	32	1	0	high	TA	2.5
2	S330	1292016	19	50	14.0		9	7	2	2	0	5.0	6	3	0	0	high	TA	3.1
1	S330	2012016	15	50	47.0	47.0	7	7	2	0	2	14.0	7	25	1	0	high	TA	2.7
2	S330	2012016	15	50	45.0		7	6	2	1	1	5.0	9	21	10	0	high	TA	2.2
1	S330	2032016	17	50	33.0	33.0	8	8	3	1	2	8.0	3	17	5	3	high	TA	2.4
1	S330	2052016	18	50	43.0		8	6	2	1	1	11.0	7	24	1	0	high	TA	2.6
2	S330	2052016	18	50	44.0	44.0	8	3	2	0	2	12.0	5	19	8	0	high	TA	2.4
1	S330	2082016	17	50	43.0	43.0	9	6	3	3	0	12.0	4	19	8	0	high	TA	2.4
1	S330	2102016	16	50	44.0		8	5	2	1	1	17.0	11	16	0	0	high	TA	3
2	S330	2102016	16	50	45.0	45.0	8	3	2	2	0	11.0	23	4	0	0	high	TA	2.5

*SCALE Code: CDS = ordering cards, CQ = Collaborative Quiz, CS = Case Study, GP = Group Project, GPS = Group Problem Solve, GW = Grammar Worksheet, PN = Ponderables, Q&A = Question and Answer, RG =Relay Game, SGD = Small Group Discussion, TA = Text Analysis, TPS = Think Pair Share

Appendix M: Raw Data for Inter-observer Reliability Calculation.

	Class and Group Demographics						ICAP Engagement level (min.)					SCALE	
Obs. No.	YouTube Class or UT Class	Date	Group Time	Group Size	M	F	Interactive	Constructive	Active	Passive	Off-Task	Level	Description/ Code*
1	1-youtube	1042016	8	5	3	2	1	4	3	0	0	Moderate	Discussion
2	1-youtube	1042016	8	5	3	2	1	4	2	1	0	Moderate	Discussion
1	2-youtube	1102016	9	8	5	3	2	1	6	0	0	Moderate	Debate
2	2-youtube	1102016	9	8	5	3	2	1	6	0	0	Moderate	Debate
1	3-youtube	1112016	2	2	1	1	1	1	0	0	0	Moderate	Peer Teach
2	3-youtube	1112016	2	2	1	1	2	0	0	0	0	Moderate	Peer Teach
1	4-youtube	1122016	5	3	1	2	0	5	0	0	0	Moderate	Discussion
2	4-youtube	1122016	5	3	1	2	1	4	0	0	0	Moderate	Discussion
1	5-youtube	1122016	16	4	3	1	0	5	11	0	0	Moderate	DiscussionSW
2	5-youtube	1122016	16	4	3	1	1	5	9	1	0	Moderate	DiscussionSW
1	M125	1132016	4	5	0	5	0	2	2	0	0	High	JigSaw
2	M125	1132016	4	5	0	5	0	1	3	0	0	High	JigSaw
1	M125	1132016	4	5	2	3	0	4	0	0	0	High	JigSaw
2	M125	1132016	4	5	2	3	0	4	0	0	0	High	JigSaw
1	G310	1132016	5	2	2	0	0	4	1	0	0	Moderate	MapReading
2	G310	1132016	5	2	2	0	0	4	1	0	0	Moderate	MapReading
1	G345	1132016	5	3	3	0	0	4	1	0	0	Low	Discussion
2	G345	1132016	5	3	3	0	0	4	1	0	0	Low	Discussion
1	G436	1192016	2	2	0	2	1	1	0	0	0	Low	TPS
2	G436	1192016	2	2	0	2	1	1	0	0	0	Low	TPS
1	M125	2242016	24	5	2	3	1	8	15	0	0	Moderate	GPS
2	M125	2242016	24	5	2	3	1	12	11	0	0	Moderate	GPS
1	G436	2252016	19	4	2	2	11	1	7	0	0	Moderate	CQ
2	G436	2252016	19	4	2	2	9	3	7	0	0	Moderate	CQ
1	S300	2242016	40	3	1	2	13	8	16	3	0	Moderate	GW
2	SP300	2242016	40	3	1	2	14	8	13	5	0	Moderate	GW

*SCALE Code: CQ = Collaborative Quiz, GPS = Group Problem Solve, GW = Grammar Worksheet, TPS = Think Pair Share

Appendix N: Pre-Observation Instructor Interviews

Interview Summaries					
Course	**Years Teaching**	**FLIP Semesters**	**FLIP Type**	**Small Group Frequency**	**Small group every class**
Basic Calculus M125	20+	8	Total	All but test days	Yes
Spanish Textual Analysis S330	22-23	12	Partial	Every day except when longer explanation, 3 times	Yes, few ex
Spanish Readings and Grammar S300	10	6	Partial	Every day, except when writing compositions	Yes, few ex
Greenhouse Management PS430	32	0	Partial	Every other week I've tried small groups for a while, with projects/group or individual through the years.	Every other week, on one of the two days, total of 5 times, for project
G345 People and Environment. G436 Water Resources G310 Introduction to Cartography	12	8	Partial	most class per.	most
PS331 Interpreting Research Findings, PS438/538 - Turfgrass Pathology	15	6	Partial	Daily, 2 of 3 days	No

Interview Summaries			
Pre-class student work	**Work students complete**	**Quizzes**	**Anything to add to pre-class?**
Notes, Video	Notetaking guide, online homework, graded online	Clicker, Class	no
Video, pre-reading, questions, read, summarize, and annotate the text. Monday, vids, short stories Wednesday, 200 words in Spanish. Portfolio, Reflection.		Not really. Ask questions to check: where, when, who, how? So, I know if they,	
Pages from the book, PPT on Bb, grammar tables, internet places to look up, mostly they use the book, textbook. PPTs are NOT video. A few PPTs from SI, they are my standard. And they do activities online before class.	Readings with emphasis on the grammar we have been covering. Readings from the texts, internet readings, papers, magazines. Use of text to identify some of the grammar structures we have been studying.	No, but first thing in class	
To get them more engaged. Hands on in groups, basically will enable hands on more importantly to get them to learn to work in groups, teams, get them engaged, employers feedback says they want them to be good at speaking, writing, team workers. This particular project writing and presenting as a team, because employers want it.	They will be having reading materials on greenhouse construction, media, every aspect of greenhouse, hydroponics, media based, soil based, construction of greenhouses. All readings and some videos by others, available on the web.	No.	There will be questions on the tests but not quizzes. Hoping they will engage, a little concerned about how to make them do the pre-work. Some do it some don't. People in the work world WANT teamwork.
More engagement, inquiry based science background, never lecture really	Readings, pre reading quiz on Bb	Yes, Bb	Readings 10 pp.
Student Engagement with material	Readings	Quiz in class	

Interview Summaries			
Typical in-class activities	**Min**	**Max**	**Rationale**
Groups, Clickers, Warmup, Concept Checks, Worksheet			P2P Interact
Story work: What do you think about the story? Groups: series of questions in group, 5-10 min. How, who, when, where? Talk as a group. 2 Class sessions on same story, M- Story 200 words in Spanish, W- Portfolio, Questions to guide analysis of the text.	2	4	To learn their culture and spanish culture, critical thinking
Essentially discuss the readings and do grammar activities. Generally groups of 2 groups of 3 in which they have to answer questions, activity sheets, discussing and reviewing the answers. Review homework, immediately review, clarify that, start to work on new material they'd read. Activity sheet, and can use textbook.	1	3	To not be redundant, work together on grammar
On break out days, time to work on some aspect of the project: organizing, decision making, team labor assignments. Teams assigned based on interest, they decide who does what. The roles are decided by the students. Before was not flip concept, this first time flip. How they work together to decide, etc. Interesting things come out, team dynamic vs. individual dynamics. Time in class and in Bb group forums, materials posted to select groups. Specific articles according to projects. Grade based on each group. 4-5 times in class. Trying to give assignments to read and extra readings based upon feedback and aggressiveness and how aggressive the group is in it's questions for information.	1	1	see earlier
Bb PPT, Discuss, theory, short vid, groups, application	1	2	Talk, P2P, confidence in speaking, public speaking, articulate thoughts, group quizzes
sit	1	2	Activities are called ponderables, read discuss material together, in pathology put together pathology fungicide program

Appendix O: Post-Observation Instructor Interviews

Post-observational Interview Summaries						
Course	**Estimated Engagement Score**	**How to Increase Eng.**	**Proportion of time students were in Small group activities on activity days (%)**	**Proportion of time in activies Students were actively Engaged (%)**	**Ways FLIP was deemed to be a Success**	**FLIP again**
Basic Calculus M125	4 - Instructor's Section ONLY	idk	50	75	1) Students Like Lecture Notes 2) Like vids for review 3) In-class peers 4) get to know if know what talking about	Definitely
Spanish Textual Analysis S330	3.8	ask students to move around more	80	85-90	1) Practice Spanish 2) Negotiate meaning together 3) Connections with own lives and culture	Yes
Spanish Readings and Grammar S300	3.5	mixup	60	95	1) Students take more responsibility for what they do 2) Not passive leads to active discussion 3) Talk in Spanish	Yes
Greenhouse Management PS430	3.8	see last page of table	8 to 10, see last page of table	80-90	see last page of table	see last page of table
G345 People and Environment; G436 Water Resources	3, 3.5	which activities work well, seating	33.3	100	1) Students engage 2) Practice material prior to exams 3) Communication 4) Dipstick assessment	Yes
PS331 Interpreting Research Findings; PS438/538 - Turfgrass Pathology	2	increase TA exp.	40-50	50	1) Hands on, integration 2) Application	Yes

Post-observational Interview Summaries						
Course		**Activities to Eliminate**	**Potential Activities to Add**	**My Present FLIP Definition is:**	**Why FLIP?**	
Basic Calculus M125		Relay	Worksheet to Activity	Lecture notes outside, In-Class Problems/Active	Increased student success	
Spanish Textual Analysis S330		No	Maybe	Different Stories?	1)push students 2) Understand better 3) Deeper Learn	
Spanish Readings and Grammar S300		Yes	or change	When students study info and come to class prepared to sicsuss and solve problems	1) students learn	
Greenhouse Management PS430		see last page of table	see last page of table	see last page of table	see last page of table	
G345 People and Environment; G436 Water Resources		IDK	Books, etc.	Where most content is viewed on own	Don't think eng., can engage more	
PS331 Interpreting Research Findings; PS438/538 - Turfgrass Pathology		No, improve	Yes, several	Using the class period to provide engaged activities in order student to apply, leaves knowledge and material traditionally in class shifted to home	1) effetive use of class time 2) students eng. 3) real world applications	

Greenhouse Management PS430, responses for Questions 2, 3, 5-10	
How to Increase Eng.	Next time I will require more pre class background reading and/or videos and I will also give clear expected outcomes for each group meeting. This time I wanted to see what subjects and how much project progress the groups would make given only general objectives for the project meetings. I wanted to see how much creative thinking came out of the group events. I feel there was a lot of creativity in the groups this year but focus and follow up could be improved with more specific expected outcomes for each meeting rather than letting thm set the pave for how fast they moved through the project goals.
Proportion of time students were in Small group activities on activity days (%)	I may expand that next time pending final results on this years group projects which count for 20% of the class grade. I also strongly encouraged all groups to meet outside of class time for at least 1 hour per week (this would be another 10% of effort on the class). I think that Perhaps half of the groups have done this so far but I think more will do this over the remainder of the semester in order to complete the projects on time.
Ways FLIP was deemed to be a Success	Do not have enough data to draw that conclusion until I see the final product of the group activity (the reports). I then can compare the quality of the group reports to reports from previous classes were I did not try the flip concept.
Will you FLIP again?	If it results in higher quality reports this year , yes. Right now I think I would because the class seems to be engaged and they seem to enjoy the interactive
Activities to Eliminate	Not so far. Not sure yet. Final written and oral reports will give me more data on how well the time spent pays off in learning and output quality.
Potential Activities to Add	But next time I may make each meeting have more specific expected outcomes rather than general expectations.
My Present FLIP Definition is:	Challenging students to take the initiative to read and or watch pertinent content related to intended learning goals needed in order to achieve a given level of expertise in the subject matter; then serving as a monitor and resource coach to assure that they can use that information to solve relevant problems related to the intended learning goals rather than lecturing on the content then asking questions from the lecture material on exams.
Why FLIP?	To see if I can stimulate a greater interest in learning and a better retention of the subject matter. See if it will keep students more engaged and interested and if it will stimulate more discussions on a higher level. Hoping that students will feel more in charge of their learning experience and respond with more effort to learn rather than memorize. End result would hopefully be better recall of, and ability to reason with,the subject matter after they graduate.

Vita

John was one of five children, born in Illinois, grew up in Illinois and New York State. He earned his undergraduate degree from Milligan College with a major in Biology and a minor in Chemistry. After a couple of years teaching he earned a Master's degree in Pomology from Cornell University. He worked for many years after that as a Research Associate II at the University of Tennessee in the Department of Plant Sciences. After working on several grants and enjoying podcasting he decided to get more education in the field of Instructional Technology. He went on to earn his Doctor of Philosophy degree in Education from the University of Tennessee.

He enjoys his continued work as a Research Associate II in Plant Sciences. John's academic interests are in cognitive load theory and learning, student engagement in small groups, active learning, program evaluation and FLIP.

John has been married to his wife, Sharon, for over thirty years. They have two daughters and six grandchildren. John enjoys his wife, children, grandchildren, parents, gardening, reading, sailing, hiking, growing fruit, and playing music.