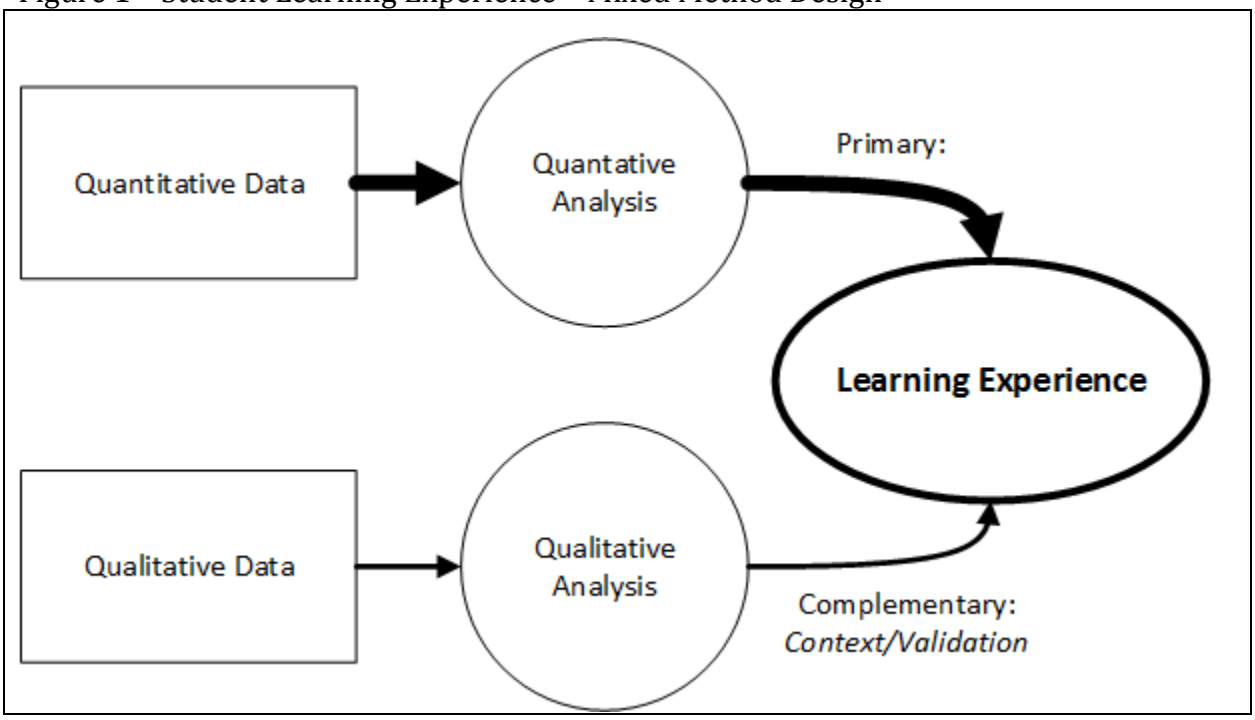
1 Method

1.1 Overview

This study used a convergent parallel mixed method design (Creswell & Plano Clark, 2011) to compare three different approaches to teaching computer programming: flipped classroom, active/collaborative and conventional lecture-based. Quantitative and qualitative data were collected at multiple points during the study. Quantitative analysis served as the primary basis to measure the student learning experience and student performance and qualitative analysis was used to provide context and explain the quantitative findings (Figure 1).

Figure 1 – Student Learning Experience – Mixed Method Design



1.2 Sample Description

Volunteers were recruited from three sections (n = 103) of a second-semester computer programming course offered in 2014 at a mid-sized community college of

applied arts and technology. The college is located in a suburban region of approximately 650,000 people. The course was offered in three sections with 31 students, 33 students, and 39 students. The student response rates for the different data-collection points in this study ranged from a high of 49.5% (n = 51) to a low of 12.6% (n = 13), with a mean response rate of 33.3% (Table 1).

Table 1 – Student Survey Response Rates

Week	Data Collection Point	N	Rate
1	Demographic/Culture of Learning Survey	50	48.5%
3	Lecture/Assignment Post-Unit Survey 1	51	49.5%
5	Active/Collaborative Post-Unit Survey 1	33	32.0%
7	Flipped Classroom Post-Unit Survey 1	38	36.9%
9	Lecture/Assignment Post-Unit Survey 2	34	33.0%
11	Active/Collaborative Post-Unit Survey 2	29	28.2%
13	Flipped Classroom Post-Unit Survey 2	13	12.6%

A majority of the participants (84%, n = 42/50) were between 18 and 24 years old (Table 2).

Table 2 – Pre-survey Student Age Ranges

Age Range	n = 50	%
Under 20*	26	52%
20 – 24	16	32%
25 – 29	5	10%
30 and over	3	6%

* Students under the age of 18 years old were excluded from this study.

Eighty-two to 100% of the participants sampled indicated that they had the prerequisite computing skills required for the blended learning environment offered in the course. Over 90% of the participants stated that they could manage files, create and edit documents, search the Internet, and use the college learning management system (LMS). Over 80% of the participants claimed they could use online collaboration tools or troubleshoot basic technical problems independently (Table 3).

Table 3 – Basic Computing Skills for Blended Learning

Serial	Variable	n	Agree+*	Disagree-**
4f.	I can usually find what I am looking for on the Internet.	50	100% (50)	0
4g.	I can use the college learning management system (i.e. DC Connect).	49	98% (48)	0
4d.	I can create and edit documents using productivity software (e.g., word processing, spreadsheets, presentation software).	49	96% (47)	2% (1)
4c.	I can organize and manage files, folders, and drives (e.g., create, locate, move, delete).	50	94% (47)	0
4k.	I can usually troubleshoot and fix basic problems with my computer with minimal help.	50	84% (42)	2% (1)
4j.	I can use a blog, wiki, and/or online discussion board to share and discuss content.	49	82% (40)	10% (5)

* Agree or Strongly Agree responses
** Disagree or Strongly Disagree responses

All participants had obtained credit for a pre-requisite introductory programming course. Most of the participants rated their programming skill level at the outset of the course as either a *developing* (52%, n = 26/50) or *intermediate* level (36%, n = 18/50). Relatively few participants rated their programming skill as at the *beginner* (8%, n = 4/50) or *advanced* level (4%, n = 2/50).

Most participants indicated that they had a moderate (n=6, 12%) or high (n=34, 68%) degree of interest in learning programming at the onset of the course. Only 20% (n=10) were slightly or not interested at all interested in programming.

1.3 Culture of Learning

At the outset of the study, students evaluated a number of teaching strategies that they may have been exposed to in the past (Table 7). Eighty to 100% of the participants responded positively to instructor-led practical demonstration of concepts or problem solving and working on hands-on problem solving on their own. Sixty-three to 75% of the participants responded positively to small group problem solving and small group discussions.

Table 4 – In-Class Learning Activity Disposition

Q#	Statement	n	Agree+*	Disagree-**
7b.	Watching the instructor demonstrate course concepts with practical examples helps my learning.	49	100% (49)	-
7e.	Working on hands-on problems on my own in class helps my learning.	49	85.7% (42)	-
7g.	Being guided by the instructor through hands-on problems as a class helps my learning.	49	85.7% (42)	4.1% (2)
7a.	Listening to the instructor explain course concepts in a lecture helps my learning.	49	81.6% (40)	-
7c.	Discussing course concepts as a class helps my learning.	48	75% (36)	6.3% (3)
7f.	Working on hands-on problems in small groups in class helps my learning.	49	73.5% (36)	10.2% (5)
7d.	Discussing course concepts in small groups in class helps my learning.	49	63.3% (31)	12.2% (6)

* Agree or Strongly Agree responses
** Disagree or Strongly Disagree responses

At the beginning of the study, students also assessed the amount of time they devoted to independent study outside of class. The expectation that four to six additional

hours of independent learning per week would be required for the computer programming courses examined in this study was communicated to all students. The majority of students responded that they typically invest up to four hours per week on work outside of class. However, over half the students indicated that they had invested six hours or more for a single college course in the past (Table 5).

Table 5 – Independent Learning Time

Question	Up to 4 hr/week*	4 to 6 hr/week	6 hr/week or more**
How much work outside of class is typical for one college course?	55.1% (27)	26.5% (13)	18.4% (9)
What is the maximum amount of work outside of class you have spent for one college course?	24.5% (12)	22.4% (11)	53.0% (26)

*Combined "Less than 1 hr/week", "1 - 2 hr/week" and "2 - 4 hr/week" responses
**Combined "6 - 8 hr/week", "8 - 10 hr/week" and "Over 10 hr/week" responses

At the outset of the study, students also rated out-of-class learning activities they had experienced in the past. Most participants agreed or strongly agreed that each of the out-of-class learning activities identified helped their learning (Table 6). Over 70% of students responded positively to hands-on problems, working in small groups, and reviewing course materials after class. Approximately 60% of students agreed or strongly agreed that review before class helped their learning.

Table 6 – Out-of-Class Learning Activity Disposition

Q#	Statement	n	Agree+*	Disagree-**
8d.	Working on hands-on homework problems on my own helps my learning.	48	75.0%	4.2%
8e.	Working on hands-on homework problems in small groups helps my learning.	47	74.5%	10.6%
8b.	Reviewing course materials (e.g., textbook, lecture notes) after class helps my learning.	48	70.8%	4.2%
8a.	Reviewing course materials (e.g., textbook, lecture notes) before class helps my learning.	48	60.4%	12.5%
8c.	Completing pre-class assignments (e.g., assigned readings and quizzes) helps my learning.	46	58.7%	17.4%

* Agree or Strongly Agree responses
** Disagree or Strongly Disagree responses

1.4 Data Collection Instruments

1.4.1 Participant Demographics

At the beginning of the study, participants were asked a set of multiple choice questions assessing demographic details including age, program of study, comfort level with computers, and level of interest in programming (**Error! Reference source not found.**, Questions 1 to 6). They were not asked to reveal their gender, whether they were an international student, nor whether they were registered with a disability, due to the moderate risk that specific individuals could be identified with the inclusion of a this information.

1.4.2 Culture of Learning

Participants were also asked a set of questions at the beginning of the study to assess the classroom culture of learning. To determine the participants' disposition towards different kinds of learning activities, they were asked to indicate their level of agreement

on a 5-point Likert scale that each of seven specific in-class activities and five specific out-of-class activities helped them learn (**Error! Reference source not found.**, Questions 7 and 8). In addition, two multiple choice questions were used to determine their disposition towards for independent learning in terms of how much time they typically spend on work outside of class and what the maximum amount of time they spent outside of class was (**Error! Reference source not found.**, Question 9).

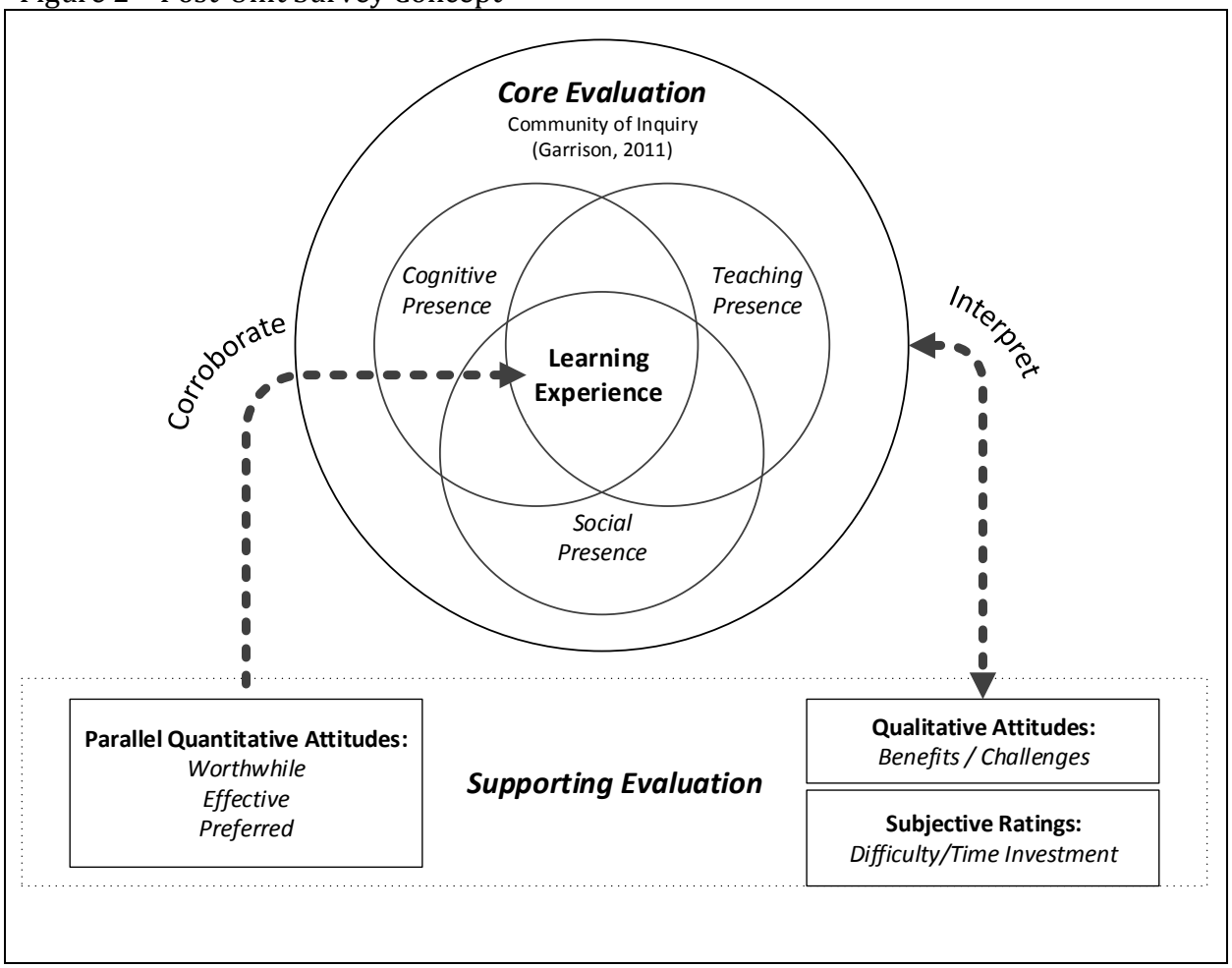
1.4.3 Student Learning Experience

Post-unit surveys were developed to solicit quantitative and qualitative data evaluating the student learning experience with each of the three teaching strategies used. These surveys included four conceptual elements: a core evaluation of the learning experience based on the Community of Inquiry (Garrison, 2011) framework (**Error! Reference source not found.**, Questions 1 to 23), quantitative measurement of parallel student attitudes to validate the core evaluation (**Error! Reference source not found.**, Questions 28 to 31), qualitative student attitudes about benefits and challenges (**Error! Reference source not found.**, Questions 32 to 33), and subjective ratings of difficulty and time investment (**Error! Reference source not found.**, Questions 24 to 27)

Figure 2 illustrates the relationships between the four conceptual elements of the student learning experience evaluation. The core evaluation element, which incorporated the students' ratings of social, cognitive, and teaching presence, served as the primary means to assess the student learning experience quantitatively. The parallel student attitudes element, which was a secondary assessment based on overall student attitudes and preferences, was used to corroborate or contradict the core evaluation results. The qualitative student attitudes about benefits and challenges, and subjective ratings of

difficulty and time investment were used to help interpret the results of the core evaluation element.

Figure 2 – Post-Unit Survey Concept



1.4.3.1 Justification for Using the Community of Inquiry Framework

The Community of Inquiry (CoI) framework (Garrison, 2011) is a social constructivist conceptual model in which the quality of a learning experience is viewed in three mutually-supporting elements: social presence, cognitive presence, and teaching presence (Garrison, 2011; Garrison, Anderson, & Archer, 2010; Swan, Garrison, & Richardson, 2009). Use of this framework has been predominately used in the context in which it was proposed:

studying online learning (Garrison, 2011; Archer, 2010). More recently this model has been applied to the study of blended learning (Archer, 2010, Garrison, 2011, Vaughan & Garrison, 2006). Archer (2010) proposed broadening the scope of CoI to include the study of courses without a substantial online element (Archer, 2010; Garrison, 2011).

Teaching presence refers to the extent of purposeful design, facilitation and direction of cognitive and social processes towards meaningful learning objectives (Garrison, 2011). It is essentially the leadership function within the community. Dimensions of teaching presence include design and organization, facilitating discourse, and providing direct instruction (Garrison, 2011, Garrison, et al., 2010). An important aspect of the concept of teaching presence is that it is not the exclusive domain of the teacher. Rather teaching presence, like social and cognitive presence, is the responsibility, to some degree, of all participants in the group (Garrison, 2011). Ryan (2013) provides a clear example of how teaching presence can be shared in a case study that examined the degree of student engagement and ownership of learning achieved by giving students a more substantial role in the design and implementation of their course. The approach taken had the instructor assume teaching presence by guiding and supporting students through the process and had the students assume teaching presence through the setting their own learning goals and designing their own final assessment (Ryan, 2013).

Social presence refers to the degree to which learners progressively identify with the larger group, communicate with purpose, and develop interpersonal relationships in the learning environment (Garrison, 2011; Garrison, et al., 2010). An important aspect of the concept of social presence is that it goes beyond a feeling of belonging and incorporates social aspects that link to purposeful inquiry, like a shared purpose and a low risk learning

climate (Garrison, 2011; Garrison, et al., 2010). Indicators of social presence are structured in three categories/dimensions: affective communication, open communication, and group cohesion (Garrison, 2011).

Cognitive presence is the degree to which the learners are able to construct meaning and confirm understanding though rigorous reflection and discourse (Garrison, 2011). The concept of cognitive presence is an elaboration on John Dewey's (1933, as cited in Swan, et al., 2009) explanation of *reflective inquiry* (Garrison, 2011; Garrison, et al., 2010; Swan, et al., 2009). Garrison, Anderson and Archer operationalized cognitive presence through the development of the *Practical Inquiry* (PI) model (Garrison, 2011; Garrison, et al., 2010; Swan, et al., 2009), which consists of four phases: the triggering event, exploration, integration, and resolution (Garrison, et al., 2010; Swan, et al., 2009).

1.4.3.2 Core-Evaluation (Teaching, Social, and Cognitive Presence Scales)

The core evaluation of the learning experience included 23 five-point Likert-scale questions seeking evidence of Garrison's (2011) three main components: *teaching presence* (**Error! Reference source not found.**, Questions 1 to 10), *social presence* (**Error! Reference source not found.**, Questions 11 to 16), and *cognitive presence* (**Error! Reference source not found.**, Questions 17 to 23). Internal reliability coefficients were calculated for the teaching presence scale (r = .95), the social presence scale (r = .92), the cognitive presence scale (r = .88), as well as a total core evaluation scale which included all 23 items (r = .95). These coefficients indicated a high degree of internal reliability for each of the scales (Table 7).

Table 7 – Core Evaluation Scales

Scale Construct Measure	Items	Range	Type	Internal Reliability
Total Core Evaluation	23	23-115	5 pt Likert-scale*	r = .95
Teaching Presence	10	10-50	5 pt Likert-scale*	r = .92
Social Presence	6	6-30	5 pt Likert-scale*	r = .88
Cognitive Presence	7	7-35	5 pt Likert-scale*	r = .86

* 1 = Strongly Disagree to 5 = Strongly Agree

1.4.3.3 Parallel Attitudes (Worthwhile, Effective, and Preferred)

Four additional 5-point Likert-scale questions were used to assess parallel attitudes participants had about their learning experience including whether the in-class learning activities featured in the unit were worthwhile, the work done outside of class was worthwhile, the overall approach was effective for learning and finally, the student would prefer most courses to follow the teaching approach used in the unit (**Error! Reference source not found.**, Questions 28 to 31). The parallel attitudes scale included these four items with a range of four to 20. The internal reliability coefficient of the parallel attitudes scale was 0.84, indicating high internal reliability. The parallel attitudes scores and the total core evaluation scores had a significant positive correlation (Pearson's $r = 0.68$, $p < .001$), suggesting concurrent validity (Litwin, 1995).

1.4.3.4 Subjective Ratings (Difficulty and Time Investment)

The difficulty level of the unit in and out of class and the degree to which time spend on learning in and out of class was appropriate were rated in subjective terms using four 5-point Likert-scale questions (Table 8) (**Error! Reference source not found.**, Questions 24 to 27).

Table 8 – Difficulty and Time Investment

Category Scale	Items	Range	Type
Difficulty Level			
In-class activities	1	1-5	5 pt Likert-scale[1]
Work outside of class	1	1-5	5 pt Likert-scale[1]
Time Investment			
In-class activities	1	1-5	5 pt Likert-scale[2]
Work outside of class	1	1-5	5 pt Likert-scale[2]

[1] 1 = Far Too Easy to 5 = Far Too Hard
[2] 1 = Far Too Little to 5 = Far Too Much

1.4.3.5 Qualitative Attitudes (Benefits and Challenges)

On the post-unit surveys, participants were what the benefits and challenges of the teaching approach used in the unit using two open-ended questions (**Error! Reference source not found.**, Questions 32 to 33). Responses were read and organized into four main categories: cognitive presence, teaching presence, social presence, and general. Each category was further divided into one to four subcategories based on an emergent content analysis (Stemler, 2001). Between two and eight themes emerged for each subcategory, for a total of 36 themes (Table 9). Refer to **Error! Reference source not found.** for detailed descriptions of each theme.

Table 9 – Qualitative Data Categories

Category	Subcategory	Themes
Cognitive Presence		
	Engagement	2
	Knowing and Understanding Basic Concepts	8
	Integrating and Applying Learning	4
Teaching Presence		
	Design/Organization	7
	Direct Instruction	3
	Guidance/Feedback	2
	Independent Learning	2
Social Presence		
	Cohesion	2
	Collaboration	3
General		
	General Assessment	3

1.4.4 Student Performance

On-line quizzes were used to assess the participants' knowledge and comprehension of each unit's content in a consistent manner. Each on-line quiz consisted of 15 multiple choice questions randomly selected from between 50 and 150 possible questions depending on the unit (Table 10). The question database included 550 multiple choice questions in total. Participants had 10 minutes to complete each quiz. After the course had completed and participants were officially notified of final grades, quiz grades were retrieved from the college learning management system. This data was anonymized, then mapped to the teaching approach used for each unit. Eighty-seven students had at least one quiz grade for each of the three teaching approaches.

Table 10 – On-line Quizzes

Unit	Quiz	Teaching Approach	Items on Quiz	Items in Database
Unit 1	Quiz 1	Lecture/Assignment	15	150
Unit 2	Quiz 2	Lecture/Assignment	15	100
Unit 3	Quiz 3	Active/Collaborative	15	50
Unit 4	Quiz 4	Flipped Classroom	15	100
Unit 5	Quiz 5	Lecture/Assignment	15	50
Unit 6	Quiz 6	Active/Collaborative	15	50
Unit 7	Quiz 7	Flipped Classroom	15	50

1.4.5 Video Analytics

In order to describe the extent to which videos were actually watched in this study, the YouTube Analytics tool was used to extract audience view and retention data from each of the 22 required videos for the two units in which the flipped classroom approach was implemented. This data was filtered to include only the data from the date each video was available to participants until the deadline for participants to submit the corresponding video worksheet homework. Table 11 describes each variable collected.

Table 11 – Video Analytic Data Collected

Variable	Description
Duration	The length of the video in minutes.
Start Date	The date the video was available to participants.
End Date	The deadline for participants to submit the video worksheet.
Views	Total views for the selected date range.
Average View Duration	The average minutes watched per view.
Average Percent Viewed	Average percent of the video viewers watched.
Less than 50% Views	The point in minutes at which the percentage of views dropped and remained* below 50%.
Views at End	The number of views at the end of the video.

* Excluding points at which views dropped below 50% but rose again.

1.5 Procedure

1.5.1 Consent

Consent to participate in the study was obtained from participants on a survey-by-survey basis during the study. Each on-line survey began with a letter (**Error! Reference source not found.**) which detailed key information for the potential participant to consider, including the anonymity and confidentiality of their responses as well as their right to refuse to participate without consequence. A consent decision question followed. A response indicating that the student did not provide consent ended the survey without further questions. It should be noted that no remunerative or grades-based incentive was offered to students for participating.

1.5.2 Teaching Approaches Design

The three specific teaching approaches developed were differentiated based on when and where *active* or *passive* learning strategies were used and whether the techniques were

collaborative or *individually-based.* They were: lecture/assignment approach, flipped classroom approach, and active/collaborative approach.

1.5.2.1 Lecture/Assignment Approach

The *Lecture/Assignment Approach* implemented in this study represented the conventional strategy for teaching this course. Formal initial exposure to new learning occurred in the face-to-face classroom. In-class activity was predominantly instructor-led lecture presenting the unit-of-study content, including step-by-step explanations of pre-prepared source code examples. These lectures featured a relatively low level of active learning, however participants were encouraged to ask questions and the instructor frequently asked questions of the participants to correct misconceptions and to keep them engaged. A lab-project was assigned as individual homework, due at the end of the unit, to provide an opportunity for the participants to apply their understanding of the unit material to a practical problem in an appropriate context.

1.5.2.2 Flipped Classroom Approach

The *Flipped Classroom Approach* began with a homework assignment. Participants were required to view between 30 and 70 minutes of on-line videos, typically in 5 to 10 minute segments, then individually submit a completed worksheet before class for marks. These videos were recorded by the instructor in his own voice and featured text, animation, and screen capture demonstrations. A small portion of in-class time was allocated to reviewing the on-line content using micro-lectures or hands-on exercises, but most of the in-class time was dedicated to working on a unit lab-project in small groups. Although lab-project work could extend from one in-class session to another, each group had to submit their progress-to-date at the end of each session. Grading and feedback was

focused on the participants' process rather than on the final product, unlike lecture/assignment approach lab-projects.

1.5.2.3 Active/Collaborative Approach

The *Active/Collaborative Approach* was designed to minimize passive learning. Structurally, this approach was similar to the conventional lecture approach in that in-class learning was focused on knowing and understanding discrete concepts, whereas deeper learning was pursued with homework. In-class activity was hands-on and peer supported. For example, rather than listening to the instructor explain pre-written source code, participants were required to input their own code as they were guided by the instructor. Instead of the instructor presenting a concept, they had to research the concept in small groups and either discuss it or write their own example to illustrate it. A unit lab-project was assigned as homework due at the end of the unit, but unlike the lecture/assignment approach version, it was assigned to small groups of participants rather than individually.

1.5.2.4 Comparing the Three Teaching Approaches

Figure 3 illustrates the key differences among the three approaches in terms of passive and active learning, individual and collaborative learning, and where major learning activities take place. In the lecture/assignment approach, students acquired a basic understanding of discreet concepts in class through relatively passive learning (e.g. listening to a lecture), then applied that content knowledge individually through lab-project completed outside of class. Students also acquired a basic understanding of discreet concepts through relatively passive learning (e.g. watching an online video) in the flipped classroom approach, however this occurred outside of class. Students in the flipped classroom then applied that content knowledge in-class through a collaborative lab-project.

In contrast, all learning activities in the active/collaborative approach were based on active learning. In the class, students acquired a basic understanding of discreet concepts collaboratively through hands-on, practical exercises. They then applied that content knowledge further through a group-based lab project completed outside of class.

Figure 3 – Teaching Approaches Comparison

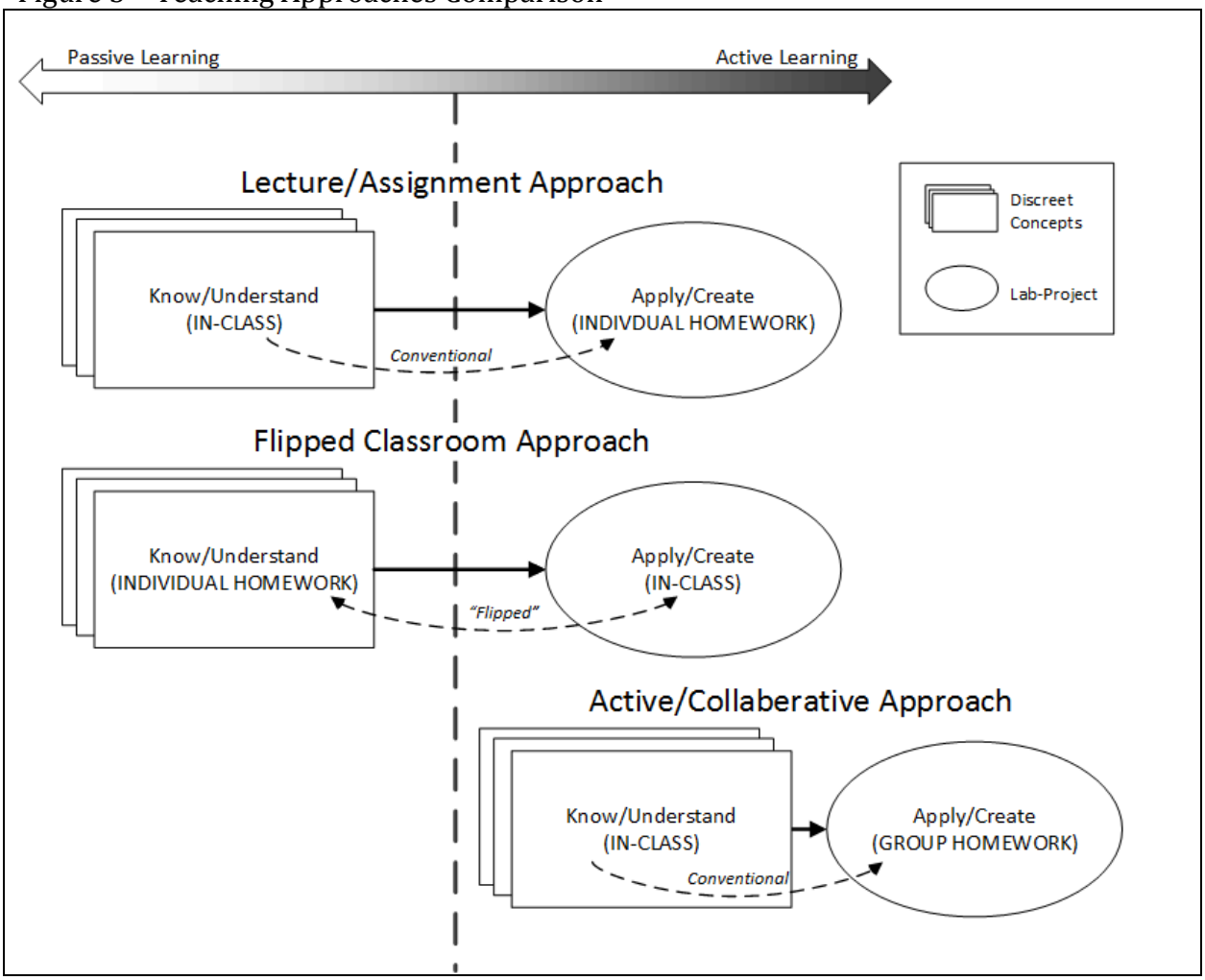


Table 12 summarizes how each teaching approach addresses the need to know and understand concepts and the need to apply concepts and create solutions.

Table 12 – Teaching Approach Comparison Summary

Level of Learning	Lecture/Assignment	Flipped Classroom	Active/Collaborative
Know & *Understand* Concepts	In-class lecture	On-line video homework	In-class hands-on exercises with peer support
Apply Concepts & *Create* Solutions	Individual lab-project homework	Small group in-class lab-project	Small group lab-project homework

It should be noted that regardless of the specific teaching approach implemented, the instructor was responsive to student requests for face-to-face or email-based support outside of class and every unit featured a robust set of supplemental learning materials.

1.5.3 Data Collection

All student survey participation was voluntary and anonymous. At the outset of the study, student demographic and culture of learning data was collected using an on-line survey (**Error! Reference source not found.**).

In the second and third weeks of the study, course material was taught using the lecture/assignment approach and the participants completed on-line quiz one and two. At the end of the third week, data was collected using the lecture/assignment approach version of the Post-Unit Survey (**Error! Reference source not found.**). In the fourth and fifth weeks of the study, course material was taught using the active/collaborative approach and the participants completed on-line quiz three. At the end of the fifth week, data was collected using the active/collaborative approach version of the Post-Unit Survey (**Error! Reference source not found.**). In the sixth and seventh weeks of the study, course material was taught using the flipped classroom approach and the participants completed on-line quiz four. At the end of the seventh week, data was collected using the flipped

classroom approach version of the Post-Unit Survey (**Error! Reference source not found.**).

The post unit survey data collection process then repeated for all three teaching methods. The eighth and ninth week of the course was taught using the lecture/assignment approach. Participants completed quiz five and were surveyed using lecture/assignment approach version of the Post-Unit Survey (**Error! Reference source not found.**). The tenth and eleventh week of the course was taught using the active/collaborative approach. Participants completed quiz six and were surveyed using active/collaborative approach version of the Post-Unit Survey (**Error! Reference source not found.**). The twelfth and thirteenth week of the course was taught using the flipped classroom approach. Participants completed quiz five and were surveyed using flipped classroom approach version of the Post-Unit Survey (**Error! Reference source not found.**).

In summary, post-unit survey data was collected at six points throughout the study. Each teaching approach was evaluated twice, six weeks apart. Concurrently, grades for on-line quizzes that corresponded to each teaching approach were recorded (Table 13).

Table 13 – Data Collection Points

Week	Unit	Survey	Post-Unit Quiz
1	-	Demographic/Culture of Learning Survey	-
2	Unit 1	-	Quiz 1
3	Unit 2	Lecture/Assignment Post-Unit Survey 1*	Quiz 2
5	Unit 3	Active/Collaborative Post-Unit Survey 1	Quiz 3
7	Unit 4	Flipped Classroom Post-Unit Survey 1	Quiz 4
9	Unit 5	Lecture/Assignment Post-Unit Survey 2	Quiz 5
11	Unit 6	Active/Collaborative Post-Unit Survey 2	Quiz 6
13	Unit 7	Flipped Classroom Post-Unit Survey 2	Quiz 7

* Participants rated their experience from both Units 1 and 2

1.6 Data Analysis

To assess differences in the student's overall perception of their learning experience between the three teaching approaches, one-way analysis of multiple variance (ANOVA) were conducted on the Total Core Evaluation Scale scores and the Parallel Attitude Scale responses. Additional ANOVAs were run to determine if any significant differences with how participants rated the difficulty level of the unit and whether their time investment was appropriate. Content analysis of open-ended survey responses was conducted and comments addressing the general category were considered.

Potential differences in the student's perception of cognitive presence between the three teaching approaches were determined using an ANOVA on the total Cognitive Presence Scale scores and an examination of open-ended survey comments relating to engagement, understanding basic concepts, and applying learning. Video analytics statistics were also examined to determine the extent to which students engaged with the online video component of the flipped classroom approach.

To assess differences in the student's perception of teaching presence between the three teaching approaches, an ANOVA was conducted on total Teaching Presence Scale scores. Open-ended survey comments relating to course design and organization, direct instruction, guidance and feedback, and independent learning were also assessed. Similarly, differences in the student's perception of social presence between the three teaching approaches were assessed using an ANOVA on the Social Presence Scale responses and an examination of open-ended survey comments relating to group cohesion and collaboration.

Finally, an ANOVA was conducted on quiz grade data to determine if any student performance differences exited among the three teaching approaches. Table 14 provides a summary of the data sources and analyses used to examine each research question.

Table 14 – Data Analysis Map

RQ#	Research Question	Data Source	Post Unit Survey Q#	Data Analysis
1.	How does the flipped classroom approach impact college students' overall perception of the learning experience in a computer programming course compared to an active/collaborative approach and a conventional lecture/assignment approach?	Total Core Evaluation Scale responses	1 to 23	ANOVA
		Parallel Attitudes Scale responses	28 to 31	ANOVA
		Qualitative responses	32 and 33	Content analysis
		Difficulty Level responses	24 and 25	ANOVA
		Time Investment responses	26 and 27	ANOVA
2.	How does the flipped classroom approach impact college students' perception of cognitive presence in a computer programming course compared to an active/collaborative approach and a conventional lecture/assignment approach?	Cognitive Presence Scale responses	17 to 23	ANOVA
		Qualitative responses	32 and 33	Content analysis
		Video Analytics		Descriptive statistics and correlation analysis
3.	How does the flipped classroom approach impact college students' perception of teaching presence in a computer programming course compared to an active/collaborative approach and a conventional lecture/assignment approach?	Teaching Presence Scale responses	1 to 10	ANOVA
		Qualitative responses	32 and 33	Content analysis

RQ#	Research Question	Data Source	Post Unit Survey Q#	Data Analysis
4.	How does the flipped classroom approach impact college students' perception of social presence in a computer programming course compared to an active/collaborative approach and a conventional lecture/assignment approach?	Social Presence Scale responses	11 to 16	ANOVA
		Qualitative responses	32 and 33	Content analysis
5.	How does the flipped classroom approach impact college students' performance in a computer programming course compared to an active/collaborative approach and a conventional lecture/assignment approach?	Quiz grades		ANOVA