

4 Results

4.1 Overview

In this study five research questions were addressed:

- RQ 1. How does the flipped classroom approach impact college students' overall perceptions of the learning experience in a computer programming course compared to an active/collaborative approach and a conventional lecture/assignment approach?
- RQ 2. How does the flipped classroom approach impact college students' perceptions of cognitive presence in a computer programming course compared to an active/collaborative approach and a conventional lecture/assignment approach?
- RQ 3. How does the flipped classroom approach impact college students' perceptions of teaching presence in a computer programming course compared to an active/collaborative approach and a conventional lecture/assignment approach?
- RQ 4. How does the flipped classroom approach impact college students' perceptions of social presence in a computer programming course compared to an active/collaborative approach and a conventional lecture/assignment approach?
- RQ 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?

The results for each of these questions will be presented in turn.

4.2 Learning Experience (Lecture, Active, and Flipped Approaches)

4.2.1 Total Core Evaluation Scale Responses

The total core evaluation scale assessed the students' overall rating of their learning experience using 23 five-point Likert-scale questions (Appendix D, Questions 1 to 23). The active/collaborative had the highest mean total core evaluation score, followed closely by the flipped classroom approach. The lecture/assignment approach had the lowest mean total core evaluation score (Table 18).

Table 18 – Total Core Evaluation Score by Teaching Approach

Teaching Approach	n	Mean	<i>SD</i>	Minimum	Maximum
Lecture/Assignment	85	82.7	16.3	23	115
Active/Collaborative	62	90.4	11.7	46	114
Flipped Classroom	51	89.2	17.4	47	115

A one-way analysis of variance (ANOVA) was conducted for total core evaluation score as a function of teaching approach was significant ($p < .05$) (Table 19). A Tukey post hoc test revealed that the mean total core evaluation score for the lecture/assignment approach was significantly lower than the means for both the active/collaborative and flipped classroom approaches ($p < .05$). Cohen's d ranged 0.39 and 0.54 for these two differences indicating that the effect sizes were moderate (Cohen, 1988, 1992). All other comparisons were not significant.

Table 19 – One-Way Analysis of Variance for Total Core Evaluation Score as a Function of Teaching Approach

Source	<i>df</i>	Sum of Squares	Mean Square	<i>F</i>
Between Groups	2	2553.4	1276.7	5.5*
Within Groups	195	45659.7	234.2	
Total	197	48213.1		

* $p < .05$

4.2.2 Parallel Attitudes Scale Responses

The parallel attitudes scale assessed students' overall rating of how worthwhile the learning activities in and out of the classroom were, how effective they found the approach, and whether this was their preferred approach (Appendix D, Questions 28 to 31). The active/collaborative approach had the highest mean parallel attitude score, followed by the flipped classroom and lecture/assignment approaches, which were similar (Table 20).

Table 20 – Parallel Attitudes Score by Teaching Approach

Teaching Approach	n	Mean	<i>SD</i>	Minimum	Maximum
Lecture/Assignment	81	14.7	3.9	4	20
Active/Collaborative	61	16.3	2.5	10	20
Flipped Classroom	51	14.9	3.4	6	20

A one-way analysis of variance (ANOVA) was conducted for parallel attitudes score as a function of teaching approach was significant ($p < .05$) (Table 21). A Tukey post hoc test revealed that the mean parallel attitudes score for the active/collaborative approach was significantly higher than the mean for the lecture/assignment approach ($p < .05$). Cohen's

d was 0.49 for this difference indicating that the effect size was moderate (Cohen, 1988, 1992). All other comparisons were not significant.

Table 21 – One-Way Analysis of Variance for Parallel Attitudes Score as a Function of Teaching Approach

Source	<i>df</i>	Sum of Squares	Mean Square	<i>F</i>
Between Groups	2	100.5	50.2	4.4*
Within Groups	190	2155.5	11.4	
Total	192	2256.0		

* $p < .05$

4.2.3 In-Class Activity Difficulty Level

The difficulty level of the learning activities in the classroom was rated using a five-point Likert-scale question. The active/collaborative, lecture/assignment, and flipped classroom approaches in-class difficulty level scores appeared to be similar (Table 22).

Table 22 – In-Class Activity Difficulty Level Score by Teaching Approach

Teaching Approach	<i>n</i>	Mean	<i>SD</i>	Too Easy ¹	Too Hard ²
Lecture/Assignment	81	3.1	(0.6)	7.4%	16.0%
Active/Collaborative	62	3.0	(0.5)	9.7%	8.1%
Flipped Classroom	51	3.1	(0.6)	3.9%	17.6%

¹ Both Too Easy and Far Too Easy

² Both Too Hard and Far Too Hard

A one-way analysis of variance (ANOVA) was conducted for in-class activity difficulty level score as a function of teaching approach was not significant ($F = 1.9, ns$).

4.2.4 Out-of-Class Activity Difficulty Level

The difficulty level of the learning activities outside of the classroom was rated using a five-point Likert-scale question. The active/collaborative approach had the lowest mean difficulty score for out-of-class activities. The flipped classroom had a lower mean out-of-class difficulty score than the lecture/assignment approach (Table 23).

Table 23 – Out-Of-Class Activity Difficulty Level Responses by Teaching Approach

Teaching Approach	n	Mean	SD	Too Easy ¹	Too Hard ²
Lecture/Assignment	80	3.3	(0.7)	6.3%	26.3%
Active/Collaborative	61	3.0	(0.6)	18.0%	13.1%
Flipped Classroom	50	3.1	(0.6)	6.0%	16.0%

¹ Both Too Easy and Far Too Easy

² Both Too Hard and Far Too Hard

A one-way analysis of variance (ANOVA) was conducted for out-of-class difficulty level score as a function of teaching approach was significant ($p < .05$) (Table 24). A Tukey post hoc test revealed that the mean out-of-class difficulty level score for the active/collaborative approach was significantly lower than the mean for the lecture/assignment approach ($p < .05$). Cohen's d was 0.46 for this difference indicating that the effect size was moderate (Cohen, 1988, 1992). All other comparisons were not significant.

Table 24 – One-Way Analysis of Variance of In-Class Difficulty Level Score as a Function of Teaching Approach

Source	<i>df</i>	Sum of Squares	Mean Square	<i>F</i>
Between Groups	2	3.6	1.8	4.3*
Within Groups	188	78.8	0.4	
Total	190	82.5		

* $p < .05$

4.2.5 In-Class Time Allocation Responses

Participants rated how appropriate the amount of time allocated to learning activities in the classroom was using a five-point Likert-scale question. A rating of three indicated that the amount of time allocated was “About Right.” The flipped classroom approach had the lowest mean in-class time allocation score, followed by the active/collaborative approach and the lecture/assignment approaches approach (Table 25).

Table 25 – In-Class Time Allocation Score by Teaching Approach

Teaching Approach	n	Mean	<i>SD</i>	Too Little ¹	Too Much ²
Lecture/Assignment	81	3.1	(0.7)	9.9%	18.5%
Active/Collaborative	62	3.0	(0.5)	11.3%	6.5%
Flipped Classroom	51	2.8	(0.5)	15.7%	3.9%

¹ Both Too Little and Far Too Little

² Both Too Much and Far Too Much

A one-way analysis of variance (ANOVA) was conducted for in-class time allocation score as a function of teaching approach was significant ($p < .05$) (Table 26). A Tukey post hoc test revealed that the mean in-class time allocation score for the lecture/assignment approach was significantly higher than the mean for the flipped classroom approach ($p < .05$). Cohen’s d was 0.49 for this difference indicating that the effect size was moderate (Cohen, 1988, 1992). All other comparisons were not significant.

Table 26 – One-Way Analysis of Variance of In-Class Time Allocation Responses as a Function of Teaching Approach

Source	<i>df</i>	Sum of Squares	Mean Square	<i>F</i>
Between Groups	2	2.6	1.3	3.7*
Within Groups	191	65.4	.3	
Total	193	68.0		

* $p < .05$

4.2.6 Work Outside of Class Responses

The amount of time spent working on learning activities outside of the classroom was rated using a five-point Likert-scale question. A rating of three indicated that the amount of time spent was “About Right.” The active/collaborative approach had the lowest mean score for work outside of class, followed by the flipped classroom approach, then by the lecture/assignment approach (Table 27).

Table 27 – Work Outside of Class Score by Teaching Approach

Teaching Approach	n	Mean	<i>SD</i>	Too Little ¹	Too Much ²
Lecture/Assignment	81	3.2	(.8)	11.1%	25.9%
Active/Collaborative	62	2.9	(.7)	21.0%	14.5%
Flipped Classroom	51	3.0	(.5)	13.7%	11.8%

¹ Both Too Little and Far Too Little

² Both Too Much and Far Too Much

A one-way analysis of variance (ANOVA) was conducted for work outside of class score as a function of teaching approach was not significant ($F=2.8, ns$)

4.2.7 Qualitative Responses (General Category)

On the post-unit surveys, participants were asked what the benefits and challenges of the teaching approach used in the unit using two open-ended questions. An analysis of

these responses revealed 47 comments relating to the student's general perception of the approach experienced (Table 28). The majority of these comments (n = 28, 60%) were from students explicitly stating that the teaching approach lacked any benefit or posed no challenges. In the remaining comments (n = 19, 40%), students remarked on the teaching approach as a whole, rather than articulating specific details.

Table 28 – Summary of General Category Qualitative Comments (n = 47)

Theme	Lecture		Active		Flipped	
	Neg	Pos	Neg	Pos	Neg	Pos
Affinity	1	1	-	1	-	1
Learning/Self-Efficacy	4	2	-	4	5	-
No Benefits/No Challenges	4	8	1	12	2	1
Total	9	11	1	17	7	2

4.2.7.1 Lecture/Assignment Responses (General)

Of the 20 student comments about the lecture/assignment approach in general, 55% (n = 11) were positive and 45% (n = 9) were negative. Most students that commented positively (n = 8) remarked that the lecture/assignment approach posed no major challenges. As one student put it, "No challenges. The lecture/assignment approach met all of my learning demands." Alternately, some students (n = 4) found the lecture/assignment approach offered few benefits. One student's response about benefits of the lecture/assignment approach was simply, "Not much." Other students (n = 4) indicated a lack of confidence in their learning stemming from the approach. For example, one student commented that "Some of the content was still unclear to me/I still don't understand a lot of what we've done."

4.2.7.2 *Active/Collaborative Responses (General)*

Eighteen comments were made about the active/collaborative learning approach in general. All but one (94%) of these comments were positive. A majority of these comments (n = 12) indicated that there were not any challenges in the approach that impacted their learning. As one student put it, "I don't think I found any challenges so far." Some students (n = 4) remarked about a greater sense understanding and confidence generally, as illustrated by this student's comment: "I feel like I learned much more in this unit than the previous two." Another student expressed their affinity for the active/collaborative approach:

I thought that this was a great way of learning new concepts in C++. Personally, I don't have much trouble understanding conceptually how the topics covered are meant to work. Getting some real hands on guided work with the new concepts syntax really brought it together and helped me understand what I needed to do to make this stuff work with the compiler. I feel that just reading off slides doesn't give us enough examples of the syntax we'll need.

4.2.7.3 *Flipped Classroom Responses (General)*

Nine student comments were about the flipped classroom approach generally. The majority of these comments (78%, n = 7) were negative. Several comments (n = 5) indicated that the flipped classroom was not effective for their learning, including three students that specifically mentioned that they felt they were falling behind. One student remarked:

I was hardly able to learn anything from this approach and am yet again feeling like I am falling behind and have greatly lost interest in computer programming as a future.

4.3 Perceptions of Cognitive Presence

4.3.1 Cognitive Presence Scale Responses

The cognitive presence scale assessed the students' ratings of how well the approach engaged them in thinking and learning. The active/collaborative approach had the highest mean cognitive presence score, followed by the flipped classroom and the lecture/assignment approaches (Table 29).

Table 29 – Cognitive Presence Score by Teaching Approach

Teaching Approach	n	Mean	SD	Minimum	Maximum
Lecture/Assignment	82	25.5	5.5	7	35
Active/Collaborative	62	27.1	4.4	14	35
Flipped Classroom	51	26.6	6.0	11	35

A one-way analysis of variance (ANOVA) was conducted for cognitive presence score as a function of teaching approach was not significant ($F=1.7$, ns)

4.3.2 Video Analytics (Flipped Learning)

Audience view and retention data was extracted using the YouTube Analytics tool for the 22 required videos of the two flipped classroom units. The average length of the videos created was 7.3 minutes ($SD = 3.9$). The average viewership as a percentage of all students ($n = 103$) was 74.1% ($SD = 14.4\%$). The average percentage of the videos viewed was 82.2% ($SD = 18.9\%$). The average point in the video at which viewership dropped below 50% was 92.3% ($SD = 9.7\%$). The average viewership retained to the end of the videos was 43.5% ($SD = 13.2\%$).

4.3.3 Qualitative Responses (Cognitive Presence Category)

An analysis of the post-unit survey responses to the open-ended benefits and challenges questions revealed 157 comments relating to the student's perception of cognitive presence (Table 30). There were more comments in this category than any other (n = 325, 48%).

Table 30 – Summary of Cognitive Presence Qualitative Comments (n = 157)

Category Theme	Lecture		Active		Flipped	
	Neg	Pos	Neg	Pos	Neg	Pos
Engagement						
Promoting Interest	1	-	-	-	2	1
Sustaining Attention	12	-	1	6	1	1
Total	13	-	1	6	3	2
Knowing and Understanding Basic Concepts						
Ability/Ease	1	3	2	5	2	7
Explained Examples	1	3	-	1	-	-
Learning by Doing	3	-	-	10	-	-
Pressure/Stress	-	-	1	1	-	-
Review for Comprehension	3	1	1	-	-	4
Technical Content/Syntax	1	-	-	2	-	-
Theoretical Content	-	2	3	-	-	-
Time to Absorb Content	3	-	1	1	-	1
Total	12	9	8	20	2	12
Integrating and Applying Learning						
Ability/Ease	7	16	2	5	8	2
Explore/Experiment	1	1	-	4	1	2
In-Class Time Allocation	2	-	1	-	2	2
Reference for Application	1	7	-	4	-	1
Total	11	24	3	13	11	7

4.3.3.1 Lecture/Assignment Responses (Cognitive Presence)

Sixty-nine comments were made about cognitive presence in the lecture/assignment approach. Of these, 52% (n = 36) were negative and 48% (n = 33) were positive.

Many students (n = 12) indicated that long lectures were particularly poor for sustaining their attention, remarking that they were boring or tiring. For example, one student commented, "Boring, lengthy lectures, making it tough to focus." Another explained, "After going beyond the required reading/assignment for the week, the lectures were a little boring." Another stated, "Long lectures can make it a bit tiring and hard to focus." A number of students (n = 7) commented that despite paying attention, completing the practical homework assignment was difficult, as expressed by this student, "I felt lost. I paid attention in the lectures, but with individual assignments, most of my friends had completed the assignment and I was left to muddle through as best I could."

However, many more students (n = 16) indicated that the lecture furnished them with enough understanding of the basic concepts to successfully complete the homework assignment. One student remarked, "I was able to follow along with the lectures and gather the information needed to complete the individual assignments." Another student stated, "[I] was given what I needed in lectures [and was able to piece the assignment together because of it." Another remarked, "[The lecture] gave me a good base of ideas to start work on my assignment... [I had] no unexpected difficulties with assignment."

Seven students mentioned specifically that the program code examples that were explained in the lectures were a valuable reference for when they were completing the homework assignment. This student explained, "He showed us most of examples in that unit and also example files so it was easy to do my assignments."

4.3.3.2 *Active/Collaborative Responses (Cognitive Presence)*

Of the 51 comments made about the active/collaborative approach with regard to cognitive presence, 76% (n = 39) were positive and 24% (n = 12) were negative. Many

comments (n = 10) indicated an appreciation for the hands-on aspect of the in-class experience. One student remarked:

I personally prefer a hands on approach. I have always found programming a lot easier to learn when you're actually coding, and not listening to theory lectures.

Some comments (n = 5) revealed that the in-class activities made understanding and retaining the basic concepts easier. One student noted, "Doing hands on work helps me understand the logic more and made it easier for me to learn." Other comments (n = 5) indicated that the active/collaborative activities in-class made it easier for several students to apply concepts to contextual problems. One student explained, "Learning hands on makes learning the syntax a lot easier, which makes it much easier to actually do the labs." Another remarked, "I really enjoyed the fact that I was able to directly apply the concepts from the in-class lesson activities for the group assignment." Additionally, some comments (n = 4) indicated that the source code students produced during the in-class learning activities served as an effective reference for later project work. As one student explained, "Thanks to the in-class examples, I had a general template for what needed to be done."

Several comments (n = 6) explained that the active/collaborative approach was effective for gaining and sustaining the students' attention in class. As one student put it, "I felt much more involved in the class, and I feel like I learned much more in this unit than the previous two." Another student explained it with enthusiasm, "This lesson was by far the most exciting and understandable lesson of all! ."

Some students commented (n = 4) that they appreciated the active/collaborative approach for the increased opportunity to explore and experiment. As one student explained, "The unit activities are always better than just straight lectures, allows me to

play around with the code and find things out myself while still having a guide. Perfect way to learn for me.”

However, a few students commented ($n = 3$) that the active/collaborative approach was not particularly effective for helping them understand theoretical content. For example, one student noted, “Understanding the theory behind each of the concepts was a bit difficult but seeing them in action helped the practicality of the information.” Another remarked, “The theory behind what I was doing was dodgy.”

Two students remarked that they had difficulty with the in-class work. One student noted, “Sometimes I struggled working on the activities” and the other commented that, “jumping into some code that I’ve never used with the exception of a few sections” was a challenge. Another student remarked about the stress of completing activities in class, “there is always a time pressure element with this type of lab submission.” Two students had difficulty integrating and applying the hands-on learning in class to the homework assignment. One noted, “When I referred back to the examples I was confused and didn’t understand some portions when trying to apply to another section.”

4.3.3.3 *Flipped Classroom Responses (Cognitive Presence)*

Thirty-seven comments were made about cognitive presence in the flipped classroom. Fifty-seven percent ($n = 21$) of these comments were positive and 43% ($n = 16$) were negative.

Four students indicated that they appreciated the ability to watch the videos as many times as was necessary. As one student put it:

I feel that having videos to watch were a very valuable part of this unit. The good thing about having videos is that you can rewind/re-watch etc. if there are any particular problems you are having with understanding a concept.

Seven students ($n = 7$) commented that watching pre-class video was an effective way for them to learn basic concepts. One student remarked:

Anybody can type the syntax needed to complete the actions related to our assignments, but I feel that understanding the logic behind the syntax is much more valuable than just telling us what to type. With the pre-class video assignments we got an idea of what the logic was before we got in the classroom, and it was presented in an easy to understand way.

However a small number of students ($n = 2$) felt that understanding some of the content in the videos was difficult. One commented, "It was somewhat difficult to fully understand some of the content and get things completed compared to other teaching methods used previously." Many students ($n = 8$) reported considerable difficulty with integrating and applying the basic concepts presented in the videos to a practical problem in class. As one student explained, "Even after watching the videos, I was still unable to complete some of the in-class labs. I feel I did not learn what I needed to in order to complete what was asked of me."

4.4 Perceptions of Teaching Presence

4.4.1 Teaching Presence Scale Responses

The teaching presence scale assessed the students' ratings of how well a particular teaching approach facilitated acquisition of learning goals. The active/collaborative approach had the highest mean total teaching presence score, followed by the flipped classroom and lecture/assignment approaches (Table 31).

Table 31 – Teaching Presence Score by Teaching Approach

Teaching Approach	n	Mean	SD	Minimum	Maximum
Lecture/Assignment	83	38.2	7.3	10	50
Active/Collaborative	60	40.9	5.2	20	50
Flipped Classroom	50	40.1	7.4	22	50

A one-way analysis of variance (ANOVA) was conducted for teaching presence score as a function of teaching approach was significant ($p < .05$) (Table 32). A Tukey post hoc test revealed that the mean teaching presence score for the active/collaborative approach was significantly higher than the mean for the lecture/assignment approach ($p < .05$). Cohen's d was 0.43 for this difference indicating that the effect size was moderate (Cohen, 1988, 1992). All other comparisons were not significant.

Table 32 – One-Way Analysis of Variance of Teaching Presence Score as a Function of Teaching Approach

Source	<i>df</i>	Sum of Squares	Mean Square	<i>F</i>
Between Groups	2	96.7	48.3	1.7*
Within Groups	192	5430.6	28.3	
Total	194	5527.0		

* $p < 0.05$

4.4.2 Qualitative Responses (Teaching Presence Category)

Eighty-eight responses to the open-ended benefits and challenges questions on the post-unit surveys related to the student's perception of teaching presence (Table 33). Approximately one third of the comments related to the guidance and feedback that was available to the students in the unit ($n = 31, 35\%$). Slightly less than a third of the comments related to the design and organization of the unit ($n = 27, 31\%$). Finally, the

remaining third of the comments were split between comments related to the amount and quality of direct instruction (n = 15, 17%) and comments related to the amount and quality of independent learning required in the unit (n = 13, 15%).

Table 33 – Summary of Teaching Presence Qualitative Comments (n = 88)

Subcategory Theme	Lecture		Active		Flipped	
	Neg	Pos	Neg	Pos	Neg	Pos
Design/Organization						
Assignment/Activity Instructions	-	1	-	-	2	-
Class Size	-	1	-	-	-	-
Content Segmenting	3	-	1	2	1	-
Grading/Incentive	-	-	-	1	-	-
Novelty	1	-	-	1	-	1
Time/Place Flexibility	3	-	-	-	4	3
Topic Coverage Efficiency	-	3	1	-	-	-
Total	5	5	2	4	7	4
Direct Instruction						
Amount/Clarity	1	3	1	-	-	-
Detailed Explanation	-	3	-	1	-	-
Signaling Priority	-	5	-	-	-	1
Total	1	11	1	1	-	1
Guidance/Feedback						
Available When Needed	4	8	1	8	1	4
Peer Support	-	-	-	1	1	3
Total	4	8	1	9	2	7
Independent Learning						
Self-Direction	-	4	-	2	2	1
Workload	3	-	-	-	1	-
Total	3	4	-	2	3	1

4.4.2.1 *Lecture/Assignment Responses (Teaching Presence)*

Forty-three comments were made about teaching presence in the lecture/assignment approach. Sixty-five percent (n = 28) of these comments were positive and 35% (n = 15) were negative.

Several students commented that the direct instruction provided in lecture clearly laid out the content (n = 3), provided in-depth explanations (n = 3), and effectively communicated what content was most important (n = 5). As one student wrote, “[Lecture provided] in depth explanation from a knowledgeable source.” Another student explained, “Gave me a good base of ideas to start work on my assignment. Highlighted what [the instructor] knew was important so I knew where to spend my energy learning.”

A number of students (n = 8) appreciated the ability to ask questions and receive an immediate answer during a live lecture. For example, one student wrote “This teaching approach gave me the opportunity to ask questions as they arose and not a few days later.” Some students (n = 4) commented that the individual homework assignment after a lecture encouraged them to solve problems independently. One student remarked, “The lecture/assignment method motivates me to try figuring out problems on my own.”

A small number of students (n = 3) commented on the difficulty of resolving questions related to the homework assignment outside of class. One student wrote, “When I do not understand something I do not know where to go for information.” A few students (n = 3) remarked that the in-class lectures were too long. A one student put it, “Two hours’ worth of talking is a lot to take in all at once.” Other students (n = 3) pointed out that to get the information presented in a lecture, they had to attend class, although this requirement

was not unique to the lecture/assignment approach. One student explained, “Missing a lecture will make it more difficult to try to catch up.”

4.4.2.2 Active/Collaborative Responses (Teaching Presence)

Twenty comments were made about teaching presence in the active/collaborative approach. Of these, 80% (n = 16) of these comments were positive and 20% (n = 4) were negative. The aspect of teaching presence for the active/collaborative approach most often mentioned (n = 8) was that immediate feedback and guidance was available when it was needed. One student remarked, “In class we are able to make mistakes, be shown mistakes and correct them with our peers and with assistance from the professor.” Another mentioned, “I was able to ask questions on the spot and got answers right away.”

Another aspect of teaching presence in the active/collaborative approach that was commented on was the value of breaking down the content into smaller segments (n = 3). As one student put it, “Solving small problems to learn how the individual pieces worked before combining and applying them in the lab assignment was helpful.” Another student pointed out, “Sometimes the course material can be confusing when trying to learn big chunks at a time.” One student notes that hands-on activities are a positive way to break up the in-class session: “The benefits came from having participation in between slight lecture times, some action to break up the lecture is nice.”

4.4.2.3 Flipped Classroom Responses (Teaching Presence)

Of the 25 comments made about the flipped classroom approach with regard to teaching presence, 52% (n = 13) were positive and 48% (n = 12) were negative. A few students (n = 3) valued the ability to watch videos outside of class when and where it was convenient for them. One student wrote, “I was able to watch the video on my own time”

and another explained, “The videos/resources that were available outside of the class room [were a benefit].” Several students felt that immediate feedback and guidance was available from the instructor (n = 4) or from peers (n = 3). For example, one student commented, “Having done the video labs before class, I was able to grasp basic concepts before class and my more advanced questions naturally came at a point when [the instructor] was available.” Another remarked, “[The flipped classroom] allowed more time to think on our own while having an instructor available for immediate questions.”

Other students (n = 2) found it difficult to find the time to watch the videos before class. One student explained, “It's very easy to forget or put off watching videos.” Another challenge mentioned (n = 2) was the degree that attendance was required. One student commented, “Some days where I couldn't make it on time, I'd miss a lot of work.” Another student noted, “If one class was missed it was hard to catch up.” One student believed that the lack of a live lecture limited their ability to ask questions: “No in-class discussions or explanations from the teacher made it difficult to ask questions on certain points when something was unclear.” Another student felt that their learning was limited by the amount of peer support they had to provide in class:

Class preparation is much more important. If people in my group were not prepared, I found I was teaching them the basic concepts instead of moving forward in my own understanding.

4.5 Perceptions of Social Presence

4.5.1 Social Presence Scale Responses

The social presence scale assessed the students' ratings of how well a teaching approach facilitated communication, group cohesion, and interpersonal relationships for the purpose of learning. The active/collaborative approach had the highest mean social

presence score, followed by the flipped classroom, then lecture/assignment approaches (Table 34).

Table 34 – Social Presence Score by Teaching Approach

Teaching Approach	n	Mean	SD	Minimum	Maximum
Lecture/Assignment	80	20.1	4.5	6	30
Active/Collaborative	61	22.9	3.6	12	30
Flipped Classroom	50	22.6	5.2	10	30

A one-way analysis of variance (ANOVA) was conducted for social presence score as a function of teaching approach was significant ($p < .05$). (Table 35). A Tukey post hoc test revealed that the mean social presence score for the lecture/assignment approach was significantly lower than the means for both the active/collaborative and flipped classroom approaches ($p < .05$). Cohen's d ranged 0.53 and 0.71 for these two differences indicating that the effect sizes were moderate (Cohen, 1988, 1992). The mean social presence scores for the active/collaborative and flipped classroom approaches were not significantly different.

Table 35 – One-Way Analysis of Variance of Social Presence Score as a Function of Teaching Approach

Source	<i>df</i>	Sum of Squares	Mean Square	<i>F</i>
Between Groups	2	320.7	160.3	8.0*
Within Groups	188	3746.2	19.9	
Total	190	4066.9		

* $p < 0.05$

4.5.2 Qualitative Responses (Social Presence Category)

Thirty-three responses to the open-ended benefits and challenges questions on the post-unit surveys related to the student's perception of social presence (Table 36). Overall, only 10% of the 325 comments made related to social presence, the least number of comments made for any of Garrison's categories.

Table 36 – Summary of Social Presence Qualitative Response Comments (n = 33)

Subcategory Theme	Lecture		Active		Flipped	
	Neg	Pos	Neg	Pos	Neg	Pos
Cohesion						
Group Identity	2	-	1	-	-	-
Keeping Pace in Class	-	1	8	1	-	-
Total	2	1	9	1	0	0
Collaboration						
Class-Level Discussion	1	2	-	2	1	1
Interdependence	-	-	3	-	1	-
Small Group Work	3	1	-	1	1	3
Total	4	3	3	3	3	4

4.5.2.1 Lecture/Assignment Responses (Social Presence)

Ten comments were made about social presence in the lecture/assignment approach. Of these, 60% (n = 6) were negative and 40% (n = 4) were positive. Half of the negative

comments (n = 3) related to the lack of group work in the approach. One student remarked, "I find learning while helping others provides better results as far as my personal learning goes." One student felt negatively about class-level discussions: "I sometimes feel that when I don't understand something I can't ask in class because everyone else understands and I don't, which makes me feel self-conscious."

Two students felt that lectures allowed for class-level discussions that were beneficial. One student explained, "The teaching approach this unit was preferable because we were able to go over the concepts together as a class." Another student felt that "No forced interaction with groups" was a benefit.

4.5.2.2 *Active/Collaborative Responses (Social Presence)*

Of the 16 comments made about the active/collaborative approach with regard to social presence, 75% (n = 12) were negative and 25% (n = 4) were positive. Most of the comments relating to social presence for this approach described either the difficulty some students had keeping pace in class with their peers (n = 6) or the disruptions caused by pausing activities to help students having difficulty (n = 2). As one student commented, "If I zoned out for even a second I would be lost or behind." Another student noted:

The only downside to this approach is having to stop the learning process to help people who make syntax errors or get left behind while the lesson is being written, but this is a small downside in my opinion considering the advantages.

Additionally, a small number of students remarked that they valued having discussions (n = 2) or doing activities (n = 1) as a class. One student remarked:

Doing the activities as a class helped me understand the concepts of the unit. I always find it effective to my learning when we go through example code together as a class.

4.5.2.3 *Flipped Classroom Responses (Social Presence)*

Of the 7 comments made about the flipped classroom with regard to social presence, 57% (n = 4) were positive and 43% (n = 3) were negative. Most (n = 5) of the comments about social presence in the flipped classroom related to working in small groups on in-class projects. Some students (n = 3) appreciated the working with other students on projects in class. One student remarked, “[It was a benefit to have] more opportunity to work within small groups to achieve the class objective.”

While one student appreciated the opportunity to discuss new concepts in groups, they disliked group-work. They explained, “[I] hated the mini group assignments. [I] don't mind group discussion about new concepts though.” One student was frustrated by the performance of their group members and another felt there was not enough class-level discussion. They explained, “I learn better when instructed and engaged in discussion with the class and professor, which is why I've opted for college as opposed to university.”

4.6 Student Performance

On-line unit quiz grades were used to assess the participants' learning performance for each unit. The active/collaborative approach had the highest mean unit quiz grade, followed by the lecture/assignment approach, then flipped classroom approaches (Table 37).

Table 37 – Unit Quiz Grades by Teaching Approach

Teaching Approach	n	Mean	SD	Minimum	Maximum
Lecture/Assignment	87	78.6	12.9	51.1	100
Active/Collaborative	87	80.8	14.9	50.0	100
Flipped Classroom	87	77.5	16.1	40.0	100

A one-way analysis of variance (ANOVA) was conducted for unit quiz grades as a function of teaching approach was not significant ($F = 1.1, ns$).