Exploring the Flipped Classroom in a Community College Setting

by

William-Thomas F. MacDonald

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Abstract

The purpose of this study was to explore the flipped classroom approach in a community college setting and assess its impact on students' learning experience and performance. Participants in this study were second semester computer programming students (n = 103) at a mid-sized community college of applied arts and technology. This study used a convergent parallel mixed method design to compare three different teaching methodologies: a flipped classroom approach, an active/collaborative approach, and a conventional lecture/assignment approach. Garrison's (2012) Community of Inquiry framework was used to assess the student learning experience afforded by each approach. The flipped classroom approach was rated significantly higher than the lecture/assignment approach in terms of the overall learning experience ($p < .05$, $d = 0.39$) and social presence ($p < .05$, $d = 0.53$). The active/collaborative approach was rated significantly higher than the lecture/assignment approach for the overall learning experience ($p < .05$, $d = 0.54$), overall attitudes and preferences ($p < .05$, $d = 0.49$), teaching presence ($p < .05$, $d = 0.43$), and social presence ($p < .05$, $d = 0.71$). There was no significant difference in student performance with regard to content knowledge among the three approaches.

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1 Introduction

1.1 Overview

The *flipped classroom*, also known as the *inverted classroom*, is a *blended learning*[1] approach that advocates reversing the customary sequence of listening to a lecture in class followed by a homework assignment outside of class, to a model where students watch multimedia lectures on-line before class, followed by completing problem-solving and application exercises in class with the instructor acting as a coach or guide (Johnson & Renner, 2012; Lage, Platt, & Treglia, 2000). The basic premise of the flipped teaching method is to move most of the passive transmission of content out of the classroom so that more class time can be invested in active and collaborative learning activities (Gannod, Burge, & Helmick, 2008; Lage et al., 2000; Toto & Nguyen, 2009). There are at least five purported advantages of using the flipped teaching approach.

First, an effective balance can be achieved between the demands of an instructor having to cover and deliver a large volume of content and the need for students to construct meaning from interacting with content (Bishop, & Verleger, 2013a; Bishop, & Verleger, 2013b, Davis & Minifie, 2013; Gannod et al., 2008; Herreid & Schiller, 2013; Lage et al., 2000; Toto & Nguyen, 2009). Second, because students are actively applying content knowledge in the classroom, the flipped teaching approach can help make students' misconceptions more visible to the instructor and provide the opportunity for the

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[1] Blended learning refers to a teaching model in which a portion of the instruction occurs in a face-to-face classroom environment and portion occurs online asynchronously (Staker & Horn, 2012).

instructor to give guidance and feedback to the students immediately (Butt, 2014; Critz & Knight, 2013; Gannod, et al., 2008; Enfield, 2013; Herreid & Schiller, 2013; McGivney-Burelle & Xue, 2013; Yeung & O'Malley, 2014). Third, the flipped classroom approach can increase student engagement and motivation (Azemi, 2013; Critz & Knight, 2013; Enfield, 2013; Frydenberg, 2013; Gannod, et al., 2008; Gaughan, 2014; Herreid & Schiller, 2013; Hoffman, 2014; Lage et al., 2000; Lasry, et al., 2014; Lucke, et al., 2013; McLaughlin et al., 2013; McLaughlin et al., 2014; Ryan, 2013; Strayer, 2012). Forth, the flipped classroom approach can improve teacher-student and peer interactions (Gannod, et al., 2008; Gaughan, 2014; Lage, et al, 2000; Pierce & Fox, 2012; Slomanson, 2014; Van Veen, 2013). Finally, the flipped classroom approach may better serve a wide array of learning styles (Bishop, & Verleger, 2013a; Herold, et al., 2012; Roehl, Reddy, & Shannon, 2013; Schwartz, 2014; Kellogg, 2009; Lage, et al, 2000; Larson & Yamamoto, 2013; Toto & Nguyen, 2009).

Although an emphasis on active and collaborative learning strategies in the classroom is inherent in the flipped classroom approach (Gannod et al., 2008; Lage et al., 2000; Toto & Nguyen, 2009), flipped teaching is typically compared to lecture-based approaches in the literature. Studies comparing the flipped classroom approach to a teaching approach based on active/collaborative learning (e.g. Guerrero, Baumgartel, & Zobott, 2013) are rare, however, such comparisons may provide insight into the relative contributions of studying content videos ahead of time versus engaging in active/collaborative activities in the classroom. No known literature is available that shows that research into flipped teaching has been conducted at the community college level.

1.2 Research Goal

The goal of this study was to explore the flipped classroom approach in a community college setting and assess its impact on student learning experience and performance. To understand its unique contributions, the flipped classroom method was compared to lecture-based and active/collaborative teaching approaches. A first year computer programming course was selected as the specific context for this study. Compared to what one might expect of an introductory programming course in an undergraduate university program, this course featured a strong emphasis on developing applied problem solving and coding skills and relatively less focus on theoretical concepts.

1.3 Research Questions

Five specific research questions were addressed in this study:

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[2] in a computer programming course compared to an active/collaborative approach and a conventional lecture/assignment approach?

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[2] Cognitive presence is the degree to which the learners are able to construct meaning and confirm understanding though rigorous reflection and discourse (Garrison, 2011).

RQ 3. How does the flipped classroom approach impact college students' perceptions of teaching presence[3] 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[4] 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' learning performance in a computer programming course compared to an active/collaborative approach and a conventional lecture/assignment approach?

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[3] Teaching presence refers to the extent of purposeful design, facilitation and direction of cognitive and social processes towards meaningful learning objectives (Garrison, 2011).

[4] 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).

2 Literature Review

2.1 Overview

This review, which spanned 2000 to 2014, focused on six key areas including the flipped classroom concept, how the flipped classroom approach was implemented in postsecondary education, student attitudes towards the flipped classroom, student behaviours in terms of engagement and preparedness, the impact of the flipped classroom approach on student performance and potential gaps in the research.

2.2 The Flipped Classroom Concept

In the *flipped classroom*, lecture-based instruction is transformed to online videos or multimedia presentations which students interact with outside of class creating the opportunity for teachers to guide students as they apply concepts collaboratively in the face-to-face classroom (FLN, 2014). The flipped classroom approach is often selected by instructors with the intent of increasing depth of engagement in the classroom class through active learning, without sacrificing the content and efficiency of the direct instruction featured in a lecture-based approach (Strayer, 2007).

In 2000, J. Wesley Baker introduced a concept called *flipping the classroom* in which technology was leveraged to transform the role of the instructor from a presenter of knowledge to a facilitator of active learning (Sales, 2013). He contended that delivering rote lecture content to students out of class over a computer network permitted in class time to be allocated towards direct support and the application of the content (Johnson & Renner, 2012). Concurrently, Lage, Platt, and Treglia (2000) outlined the synonymous *inverted classroom* teaching strategy in a seminal study of an undergraduate introductory microeconomics course taught in 1996 (Roehl, et al., 2013). Their aim was to appeal to a

broad range of learning styles without incurring unrealistic costs in terms of student contact. The model they implemented included pre-class preparatory *homework* consisting of a variety of options for the student, including but not limited to pre-recorded video and multimedia. Class time featured short *mini-lectures* to address questions from the pre-class material, followed by active/collaborative activities and independent work. They described inverting the classroom as assigning what was conventionally an in-class learning activity (e.g., listening to a lecture) as homework, and using in-class time for what was conventionally done as homework (e.g., applying concepts) (Lage, et al., 2000).

2.2.1 Defining Elements of the Flipped Classroom

In the flipped classroom, instructors deliver *lectures* outside of class through technology, then facilitate an *active learning* approach in the classroom. Each of these defining elements will be discussed in turn.

2.2.1.1 Lecture-Based Teaching

Lecturing is one of the most prominent teaching methodologies in colleges and universities today (Bishop & Verleger, 2013b; Bligh, 2000; Brown & Race, 2005; Cashin, 1985; Charlton, 2006; Davis & Minifie, 2013; Gary, Lindquist, Bansal, & Ghazarian, 2013; Roehl, et al., 2013). A lecture can be an especially effective way to convey relatively large amounts of content knowledge to numerous students efficiently (Bligh, 2000; Brown & Race, 2005; Cashin, 1985; Charlton, 2006), while offering at least some potential for dynamic interaction between the expert instructor and the novice student in a shared environment (Brown & Race, 2005). While individual and small-group teaching offer considerably more dynamic interaction, such approaches are much more costly and may be impractical to implement at larger scales (Charlton, 2006; Brown & Race, 2005). A skilled

lecturer can promote student engagement by conveying a sense of passion for the material that is difficult to communicate other ways (Cashin, 1985). By piquing their interest, an engaging lecture can serve to motivate students to learn more (Brown & Race, 2005; Race, 2007). An instructor can also signal what aspects of the material are important (Race, 2007). For students, learning from lecture may be less cognitively taxing, because the content knowledge is organized by the instructor and presented directly (Charlton, 2006; Kirschner, Sweller, & Clark, 2006).

On the other hand, a number of problems have been identified with using a lecture-based approach. Lecturing may not be effective at promoting levels of learning beyond knowledge and comprehension (Bligh, 2000; Cashin, 1985; Charlton, 2006), nor suited for developing practical skills (Bligh, 2000; Bonwell, 1996; Cashin, 1985; Charlton, 2006). As such, it is not unusual to pair lectures with other learning activities, such as discussions and labs, in order to teach application, analysis and synthesis or to influence attitudes or values (Bligh, 2000; Brown & Race, 2005; Cashin, 1985). In addition, lectures may not be sufficiently tailored to the specific needs of individual students (Cashin, 1985). This particular weakness may be exacerbated as access to postsecondary education becomes more open and student populations become more diverse (Brown & Race, 2005). Moreover, during a lecture, instructors may have only limited feedback from which to assess the students' comprehension (Cashin, 1985). Asking questions is usually helpful in this regard (Cashin, 1985; Race, 2007), as is being sensitive to nonverbal clues (Cashin, 1985), but these techniques fall short of the robust feedback that is intrinsic to individual and small-group teaching. Finally, sustained attention is required for lectures to be effective, however, expecting students to stay focused for extended periods of time may not

be realistic (Cashin, 1985). Some suggest pausing lectures frequently to engage students in some other learning activity in order to recapture their attention (Bownwell, 2006; Cashin, 1985; Richardson, 2007).

One of the defining elements of the flipped classroom approach is the delivery of some lecture content via a digital means (Johnson & Renner, 2012; Lage, et al., 2000; Stayer, 2012). By *moving* this type of instruction out of the classroom rather than eliminating it entirely, the flipped classroom may retain some of the advantages of lecturing, such the potential to cover a large number of topics efficiently (Bishop, & Verleger, 2013a) and the ability to present information in manner that may be less cognitively taxing for students. Unlike a face-to-face classroom lecture, students have the added freedom to choose when, where, and how to view the content (Amiri, Ahrari, Saffar, & Akre, 2013; Boucher, Robertson, Wainner, & Sanders, 2013; Forsey, Low, & Glance, 2013; Guerrero, et al., 2013; Lucke, Keyssner, & Dunn, 2013; Yeung & O'Malley, 2014), however, students cannot ask questions in the moment and receive feedback immediately. With time freed-up in the classroom, a flipped classroom instructor is free to implement teaching methods that may better address higher levels of learning and practical skills development (Johnson & Renner, 2012; Lage, et al., 2000; Stayer, 2012).

2.2.1.2 Active Learning

Another defining element of the flipped classroom involves increasing the amount of active learning in the face-to-face classroom (Bishop, & Verleger, 2013a; Gannod, et al., 2008; Lage, et al., 2000; Stayer, 2012). In recent decades there has been a growing interest moving away from the *passive* learning offered by lectures and towards incorporating *active* learning strategies (Bonwell, 1996; Charlton, 2006; Michael, 2006; Richardson,

2008). Active learning describes activities in which the student learns through the meaningful application of knowledge (Frydenberg, 2013), employing higher order thinking skills such as analysing, evaluating and synthesizing (Bonwell & Eison, 1991; Roehl, et al., 2013) , and reflection (Bonwell & Eison, 1991; Frydenberg, 2013; Michael, 2006; Roehl, et al., 2013). Active learning strategies are often considered *student-centred* in that the student manages how individual learning goals are achieved (Bishop, & Verleger, 2013a; Critz & Knight, 2013; Ferreri & O'Connor, 2013; Gannod, et al., 2008; Herold, Lynch, Ramnath, & Ramanathan, 2012; Hoffman, 2014; Michael, 2006; Schwartz, 2014; Taylor, McGrath-Champ, & Clarkeburn, 2012; Wilson, 2013).

Bonwell and Eison (1991) provide a succinct definition of active learning: "instructional activities involving students in doing things and thinking about what they are doing" (p. 1). With this broad definition, a diverse set of activities might be considered to be active learning (Bonwell & Eison, 1991; Richardson, 2008). Listening and taking notes during a lecture are not generally considered active enough to meet the criteria, but embedding short interactive exercises periodically in otherwise conventional lectures is not an uncommon active learning approach (Bownwell, 2006; Bonwell & Eison, 1991; Race, 2007; Richardson, 2008). In such cases, instructors cede some control over the pace of learning in class to the students, but within a defined framework (Richardson, 2008). More radical active learning approaches are based on the principle that learning is most effective when students construct their own solutions to substantial, ill-defined problems with minimal instructional guidance (Bonwell & Eison, 1991; Kirschner, et al., 2006). Such approaches are also referred to as discovery learning, problem-based learning, inquiry learning, or experiential learning (Kirschner, et al., 2006).

Considerable evidence suggests that many active learning techniques are effective (Bonwell, 1996; Bonwell & Eison, 1991; Michael, 2006; Richardson, 2006). Advocates contend that active learning is superior to lectures in developing thinking and problem-solving skills (Bonwell, 1996; Bonwell & Eison, 1991, Davis & Minifie, 2013), improving student attitudes and achievement (Bonwell, 1996; Bonwell & Eison, 1991; Davis & Minifie, 2013), engaging students in learning (Bonwell & Eison, 1991; Davis & Minifie, 2013; Grant 2013), developing self-directed learning (Toto & Nguyen, 2009), and better serving learning styles that a significant number of individuals have (Bonwell, 1996; Bonwell & Eison, 1991). They also suggest that active learning is comparable to a lecture-based approach at inculcating content knowledge (Bonwell & Eison, 1991; Grant 2013).

Collaborative learning is a subset of active learning (Bishop, & Verleger, 2013a) in which groups of students work together to complete tasks, solve problems, or create a product (Laal & Laal, 2012) in order to help each other build knowledge and understanding (Grant, 2013). Considerable evidence suggest that collaborative learning promotes critical thinking and deeper understanding (Grant, 2013; Laal & Laal, 2012), improves retention and learning outcomes (Grant, 2013; Michael, 2006), increases student interest and engagement, (Grant, 2013; Laal & Laal, 2012) and sets conditions for students to take responsibility for their own learning (Laal & Laal, 2012). Research also suggests that collaborative learning activities have cognitive and motivational benefits over individualistic activities (Järvelä, Volet, & Järvenoja, 2010; Michael, 2006). Lou et al. (1996) conducted a meta-analysis of 66 studies concerning the impact of in-class grouping in student achievement and attitudes. On average, students who learned in small groups in class had significantly higher achievement, significantly more positive attitudes towards

the subject matter, and a significantly higher general self-concept compared to students in non-grouped classes (Lou et al., 1996).

Despite the apparent benefits, implementing active/collaborative learning in practice can be challenging. Active learning techniques typically require that students have a common foundation of knowledge about a subject to begin with (Davis & Minifie, 2013; Kirschner, et al., 2006). Active learning can be more resource intensive than a lecture-based approach and is challenging to implement with a large number of students due to the increased interaction in the classroom (Bonwell & Eison, 1991). Instructors may be faced with institutional pressure to contain costs by having larger class sizes (Bishop, & Verleger, 2013a; Bishop, & Verleger, 2013b, Davis & Minifie, 2013; Lage, et al, 2000) rendering a purely active/collaborative approach untenable. There is also evidence that suggests that minimal guidance approaches are significantly less effective than techniques featuring explicit instructor guidance (Kirschner, et al., 2006).

With the flipped classroom approach, the pre-class lecture content may prepare students with the common foundation of knowledge required for effective active/collaborative learning in the classroom (Boucher, et al., 2013; Critz & Knight, 2013; Forsey, et al., 2013; Gaughan, 2014; Guerrero, et al., 2013; McGivney-Burelle & Xue, 2013; McLaughlin et al., 2013; McLaughlin et al., 2014; Slomanson, 2014; Toto & Nguyen, 2009; Yeung & O'Malley, 2014).

2.2.2 Criticisms of the Flipped Classroom

Critics suggest that the flipped classroom as it is typically implemented remains a largely lecture-based, teacher-centric construct, albeit enhanced by technology (Ash, 2012; Bishop & Verleger, 2013a; Hoffman, 2014; Strayer, 2007; Strayer, 2012). Some suggest

constructivist learning theory should inform a radical redesign of the approach as a whole (Hoffman, 2014) and that active, student-centred pedagogy should be evident inside and outside of the classroom (Becker, 2013; Hoffman, 2014; Strayer, 2007; Strayer, 2012). For example, rather than requiring students to passively watch a pre-recorded video lecture before coming to class, students should be actively engaged with pre-class activities like on-line interactive tutorials (Becker, 2013; Boucher, et al., 2013; Cheng, 2013; Kellogg, 2009; Kellogg, 2013), electronic tutoring systems (Strayer, 2007; Strayer, 2012), and collaborative content creation (Grant, 2013; Talley & Scherer, 2013).

2.3 Implementation of the Flipped Classroom

In order to determine how the flipped classroom approach is typically implemented in a postsecondary environment, a literature search was conducted using a variety of databases and search tools including Google Scholar, the University of Ontario Institute of Technology (UOIT) Library Search, and Educational Resources Information Center (ERIC) via ProQuest. Keywords used included “flipped classroom”, “inverted classroom”, “classroom flip”, and “inverted teaching.” Further literature as found by screening the references provided in key articles. From this list, only peer reviewed journal articles were selected that evaluated original implementations of the flipped classroom strategy in a postsecondary environment. This search process yielded a list of 49 studies across multiple academic disciplines. Each of these studies was analysed to identify key components of a flipped classroom including the format of the pre-class learning activities, the major categories of in-class learning activities, and strategies for linking the two. Each of these areas will be discussed in turn. Detailed information from this analysis is presented in Appendix A.

2.3.1 Pre-Class Activities

Each of the 49 selected articles was analysed to determine the major formats of pre-class learning activities used in the flipped classroom (Table 1). Nine of ten flipped classrooms studied featured on-line videos and/or other forms of multimedia in the pre-class component. This suggests that the use video/multimedia is considered a definitive aspect of the flipped classroom approach. Almost half of the flipped classrooms also implemented pre-class reading assignments. Other, less-used, pre-class activity formats included supplemental learning materials, out-of-class collaboration, and multiple alternative formats (Table 1).

Table 1 – Pre-Class Activity Format Breakdown

Category	Description	Articles (n = 49)	% of Articles
Online Video and Multimedia	Various formats, including: • Online content video produced by the instructor (n = 30). • Interactive multimedia with embedded feedback such as eTutoring systems and dynamic learning tools (n = 5). • Content video sourced from an on-line repository (e.g. Khan Academy) (n = 5). • Multimedia presentations such as lecture slides with embedded audio (n = 3). • Video recording of prior in-class lecture (n = 2). • Online content video, source not specified (n = 1).	44	89.8%
Reading Assignments	Text-based assigned readings.	21	42.9%
Supplemental Learning Materials	Text-based notes, guides, other supporting learning materials/links.	10	20.4%
Out-of-Class Collaboration	Out-of-class collaborative activities such as on-line discussion and group assignments.	3	6.1%
Multiple-Alternative Formats	The whole of the intended learning provided in multiple redundant formats.	2	4.1%

2.3.1.1 Online Video and Multimedia

The most common pre-class learning activity reported in the selected articles involved students watching on-line content videos (n = 38, 78%), the majority of which (n = 30, 61%) were short, segmented videos produced by instructors. Pre-class learning activities based on the use of multimedia formats other than online video was evident in eight of the selected articles (16%). The sophistication of the multimedia used ranged from relatively simple formats, such as PowerPoint slides with embedded audio (Bijlani,

Chatterjee, & Anand, 2013; Herold, et al., 2012; Lage, et al, 2000) to elaborate electronic tutoring systems with embedded interactive visualizations, dynamic problem solving exercises and intelligent feedback (Kellogg, 2009; Kellogg, 2013; Lucke, et al., 2013; Sadaghiani, 2012; Strayer, 2012).

2.3.1.2 Reading Assignments

Twenty-one of the selected articles (43%) describe engaging students in pre-class learning using assigned readings, however in most cases (n = 17), readings were only one of multiple pre-class activities identified. Four articles (8%) featured reading assignments as the exclusive source of pre-class content (Butt, 2014; Davis & Minifie, 2013; Ferreri & O'Connor, 2013; Murphree, 2014).

Considering a classroom to be flipped when the sole pre-class component was assigned readings was not unanimously accepted in the literature. In their recent survey of research, Bishop and Verleger (2013a) noted that such broad definitions made it impractical to assess the flipped classroom meaningfully. It was also noted that significant numbers of students do not complete reading assignments (Bishop, & Verleger, 2013a, Sadaghiani, 2012). Both Lage, Platt, and Treglia (2000) and Baker explained that moving lecture content out of the classroom is facilitated through technology (Johnson & Renner, 2012). Strayer (2012) suggested that instructors have assigned pre-class readings for decades, but the use of interactive technology is what made the flipped classroom model unique (p. 172).

2.3.1.3 Supplemental Learning Materials

Ten of the selected articles (20%) explicitly mentioned the use of other learning materials to support the pre-class component in addition to on-line video, assigned

readings or multimedia. These materials included notes, guides and links to supplemental learning resources. For example Taylor, McGrath-Champ, and Clarkeburn (2012) supplied students with short audio podcasts to provide context to the readings required for team-based learning activities in the classroom. The selection of the audio podcast format was intended to address student perceptions that active-learning relies too heavily on students learning from other students and lacks communication from an expert (Taylor, et al., 2012).

2.3.1.4 Out-of-Class Collaboration

Three of the selected articles (6%) mentioned using out-of-class collaboration as a significant component of pre-class learning. Ryan (2013) describes small groups of students working together outside of class to advance their in-class projects through the university's learning management system, social media, and face-to-face meetings. Hoffman's (2014) case study had students engaged in online discussion before class alongside reading assignments and supplemental on-line videos. Similarly, Herold, Lynch, Ramnath, and Ramanathan (2012) required students to participate in email-based discussion in concert with their use of the multiple alternative format approach to pre-class learning.

2.3.1.5 Multiple-Alternative Formats

Two of the selected articles (4%) implemented a distinct strategy in which the intended pre-class learning content was provided to students in multiple redundant formats, including video, multimedia, and text-based readings. The intent of this strategy was to furnish students with the opportunity to select how to interact with the content based on their own preferences (Herold, et al., 2012; Lage, et al, 2000). Although a clear multiple alternative format strategy was implemented infrequently, differentiating

instruction based on learning style was regularly discussed by a number of researchers (Bishop, & Verleger, 2013a; Herold, et al., 2012; Roehl, et al., 2013; Schwartz, 2014; Kellogg, 2009; Lage, et al, 2000; Larson & Yamamoto, 2013; Toto & Nguyen, 2009).

2.3.2 In-Class Learning Activities

The mix of specific in-class learning activities implemented in flipped classrooms varied considerably, however all studies featured some form of active learning strategy. About three quarters of the articles examined either in-class application activities with limited instructor direction, group discussion and/or peer presentations. Just over half the studies involved some form of collaboration among students. Only three studies looked at in-class activities requiring reflection such as journal writing (Table 2).

Table 2 – In-Class Learning Activity Breakdown

Type	Description	Articles (n = 49)	% of Articles
Application	Application activities with less instructor direction such as problem-based learning, guided inquiry, case study, and projects.	37	75.5%
Discuss/Peer	In-class group discussion and peer presentations.	35	71.4%
Collaboration	Collaborative learning activities such as group project/problem solving, role playing, and think-pair-share.	26	53.1%
Directed	Structured active learning activities with instructor direction such as interactive demos, step-by-step instruction, practice tests, and clickers.	20	40.8%
Reflection	In-class reflection-based activities such as journal writing.	3	6.1%

The flipped classroom described by Davies, Dean, and Ball (2013) was unique among the selected studies in that exclusive purpose of the in-class component was to provide remedial support to those students that felt they needed help. Attending class was not required, meaning that all learning objectives could be met by the students through asynchronous learning activities (Davies, Dean, & Ball, 2013). This represents a departure from the more common viewpoint that the face-to-face component of the flipped classroom is vital (Bishop, & Verleger, 2013a; Lage, et al, 2000; Sales, 2013; Toto & Nguyen, 2009).

2.3.3 Strategies for Linking Pre-Class and In-Class Activities

The majority of the articles described activities or strategies to link pre-class learning to in-class learning (Table 3). In half of the studies some form of a gateway quiz or assignment was used to verify that students had acquired the pre-class material. In nearly 40% of the studies, pre-class learning was directly linked to in-class activities either explicitly or implicitly with pre-assigned discussion questions or initial elements of an application project/task that was continued in class. Other linking strategies included students posting questions or feedback on-line (Bijlani, et al., 2013; Butt, 2014), or conducting a short in-class lecture reviewing pre-class content (Azemi, 2013; Butt, 2014). See Table 3 for a summary of linking strategies used.

Table 3 – Strategies for Linking Pre-Class and In-Class Activities

Category	Description	Articles (n = 49)	% of Articles
Gateway Quiz/Assignment	Various formats, including: • Online quiz or test before class (n = 9) • In-class quiz or test (n = 8). • Pre-class content applied in a graded activity or assignment (n = 7). • Practice quiz or test (n = 1).	25	51.0%
Direct Links	Pre-class content linked directly to in-class activities, including: • Pre-class content explicitly required for-class discussion, presentation or task (n = 10). • Implicit understanding that the pre-class content would be applied or discussed in class (n = 8).	18	36.7%
Online Posting of Questions/Feedback	On-line posting of student feedback or questions before class.	2	4.1%
In-Class Lecture Review	Brief in-class review lecture/discussion.	2	4.1%

2.4 Student Attitudes towards the Flipped Classroom

An analysis of the literature revealed seven themes relating to student attitudes towards the flipped classroom including overall attitudes, pedagogical change, perceptions of learning quality, collaboration, instructor interaction, video/multimedia, and workload. Each of these themes will be discussed in turn.

2.4.1 Overall Attitude

Fifteen studies reported that students had positive attitudes towards the flipped classroom approach by the end of their experience. This included studies in which

students commented positively on surveys (Arnold-Garza, 2014; Butt, 2014; Enfield, 2013; Gannod, et al., 2008; Guerrero, et al., 2013; Van Veen, 2013), during interviews (Findlay-Thompson & Mombourquette, 2014; McGivney-Burelle & Xue, 2013; Taylor, et al., 2012), or through informal feedback (Lucke, et al., 2013). It also included studies in which students rated the flipped classroom positively on a set scale (Hoffman, 2014; Lage, et al, 2000; Love, Hodge, Grandgenett, & Swift, 2014; McGivney-Burelle & Xue, 2013; Schwartz, 2014; Taylor, et al., 2012) and studies in which students expressed interest in enrolling in future flipped courses (Davies, et al., 2013; Hoffman, 2014).

Twelve studies reported that students felt the flipped classroom approach was better than the traditional lecture-based approach (Frydenberg, 2013; Lage, et al, 2000; Larson & Yamamoto, 2013; Lasry, Dugdale, & Charles, 2014; McLaughlin et al., 2013; McLaughlin et al., 2014; Murphree, 2014; Pierce & Fox, 2012; Sadaghiani, 2012; Schwartz, 2014; Slomanson, 2014; Van Veen, 2013), however some students preferred a more traditional teaching approach (Arnold-Garza, 2014; Findlay-Thompson & Mombourquette, 2014; Guerrero, et al., 2013; Larson & Yamamoto, 2013, Van Veen, 2013). Van Veen (2013), for example, contended that some students do not appreciate actively engaging in learning to the degree required by the flipped classroom approach.

Students from two studies felt that the flipped classroom approach was only suitable for more senior students (Mason, et al., 2013a; Yeung & O'Malley, 2014). Mason, et al. (2013a) surveyed flipped classroom students and found that approximately one third agreed it was only appropriate in fourth year classes (31%), one third felt that flipped teaching was appropriate in third year and beyond (32%), and finally one third agreed that was only appropriate after first year (37%). None of the students they surveyed felt that

the flipped classroom approach was suitable for first-year students. Likewise, Yeung and O'Malley (2014) reported that some students commented that flipped teaching was only appropriate for third and fourth year students due to the high degree of independent learning required.

Four studies reported negative student attitudes towards the flipped classroom. Amresh, Carberry, and Femiani (2013) noted that students felt overwhelmed by the flipped classroom approach. Students claimed that the pre-class were videos boring and the in-class assignments were intimidating (Amresh, Carberry, & Femiani, 2013). Missildine, Fountain, Summers, and Gosselin (2013) observed that students in the flipped classroom implementation were significantly less satisfied than students in lecture-based classes despite achieving significantly higher exam grades. Strayer (2012) found that students in the flipped classroom valued innovation and collaboration more than students in the traditional classroom but felt disoriented by the approach. Finally, Tune, Sturek, and Basile (2013) stated that approximately half of the student opinions were positive and half were negative. Students tended to appreciate in-class discussions but felt the flipped classroom approach generally required more effort than was reflected by the number of credits they earned (Tune, Sturek, & Basile, 2013).

2.4.2 Attitudes towards Pedagogical Change

Four studies reported that students recognized that the flipped classroom approach was distinctive from the lecture-based approaches they were more familiar with (Guerrero, et al., 2013; Mason, Shuman, & Cook, 2013a; Pierce & Fox, 2012; Ryan, 2013) and that the approach required an adjustment to their study habits (Guerrero, et al., 2013; Mason, et al., 2013a). Strayer (2012) reported that the set routine of the traditional classroom helped

the students cope with slight changes in how the class was conducted, but that in the flipped classroom, students never felt completely comfortable.

While not all students were supportive of the flipped classroom approach early in the experience (e.g. Forsey, et al., 2013), in three studies acceptance improved over time (Butt, 2014; Mason, et al., 2013a; Van Veen, 2013). During an in-class discussion in the fourth week of a flipped classroom course, Mason, Shuman, and Cook, (2013a) found that students were initially frustrated with the approach but were beginning to adjust to the need to come to class prepared. They ultimately felt that the flipped approach lead to better use of class time and prepared them for practice (Mason, et al., 2013a). Butt (2014) surveyed students about their perceptions of the flipped classroom approach at the start and end of a course. Students that indicated an unfavourable view of approach in the beginning showed strong support for the flipped classroom by the end of the course (Butt, 2014). Van Veen (2013) reported that student feedback early in the semester was mixed. Students appreciated the video lectures but some missed the conventional lecture format. By the end-of-semester evaluations however, less than 10% of students indicated a preference for a lecture-based approach (Van Veen, 2013).

2.4.3 Perceptions of Learning Quality

Twenty studies reported that students felt that the teaching and learning strategies of the flipped classroom helped improve their understanding of the course material and had a positive impact on their learning. Students from several studies self-reported agreement that the flipped classroom improved the quality of learning compared to traditional approaches (Amiri, et al., 2013; Bijlani, et al., 2013; Frydenberg, 2013; Larson & Yamamoto, 2013; Lucke, et al., 2013; McLaughlin et al., 2014; Murphree, 2014). Students

from many studies indicated their perception that the in-class learning activities were effective (Arnold-Garza, 2014; Critz & Knight, 2013; Love, et al., 2014; Mason, Shuman, & Cook, 2013b; McLaughlin et al., 2014;), pre-class activities were helpful (Arnold-Garza, 2014; Critz & Knight, 2013; Davis & Minifie, 2013; Enfield, 2013; Gaughan, 2014; Guerrero, et al., 2013; Larson & Yamamoto, 2013; Love, et al., 2014; Mason, et al., 2013b; McGivney-Burelle & Xue, 2013; McLaughlin et al., 2013; McLaughlin et al., 2014), and the flipped classroom approach led to higher achievement (Amiri, et al., 2013; Findlay-Thompson & Mombourquette, 2014). Students from a number of studies agreed that knowledge and skills developed in the flipped classroom were relevant to practice (Ferreri & O'Connor, 2013; Love, et al., 2014; McLaughlin et al., 2014; Ryan, 2013). A number of studies indicated that students reported greater self confidence in their ability to apply the knowledge and skills they developed (Amresh, et al., 2013; Ferreri & O'Connor, 2013; McLaughlin et al., 2014; Pierce & Fox, 2012; Sales, 2013). Some students reported that the flipped classroom approach developed their critical thinking, problem solving, and interpersonal skills (Ferreri & O'Connor, 2013; McLaughlin et al., 2013). Some students found the approach encouraged them to be independent learners (Amiri, et al., 2013; Enfield, 2013; Taylor, et al., 2012), however Ferreri and O'Connor (2013) reported that the students' perceptions of their ability to manage their own learning was unchanged.

Four studies noted that some students reported frustration by the pace of the flipped classroom in-class activities (Amresh, et al., 2013; Butt, 2014; Enfield, 2013; Larson & Yamamoto, 2013) and having to wait for others who needed help and were slower to finish (Butt, 2014; Enfield, 2013; Larson & Yamamoto, 2013). Finally, some students felt the

requirement to complete assignments during in-class time was intimidating (Amresh, et al., 2013).

2.4.4 Attitudes towards Collaboration

Students from seven studies viewed working collaboratively with peers in class as a positive feature of the flipped classroom approach (Amiri, et al., 2013; Ferreri & O'Connor, 2013; Frydenberg, 2013; Lage, et al, 2000; Love, et al., 2014; Ryan, 2013; Strayer, 2012). Strayer (2012) found that students in the flipped classroom were more willing to work together in class than students in the traditional approach. Ryan (2103) reported that some students had negative attitudes about group-work initially, because they feared that grades would not be distributed equitably and that individual effort would not be recognized appropriately. He noted that the students' attitudes toward collaboration changed over the course of the semester as they developed a sense of team spirit (Ryan, 2013). Frydenberg (2013) also observed that the flipped classroom approach promoted camaraderie and team spirit, however, Forsey, Low, and Glance (2013) noted that some students felt that the absence of a lecture created a sense of fragmentation from the larger student body.

Five studies indicated that the flipped classroom approach provided a favourable environment for sharing ideas (Amiri, et al., 2013; Tune, et al., 2013) in which students were comfortable with one another (Lage, et al, 2000; Sales, 2013; Love, et al., 2014). Six studies reported that the quantity (Arnold-Garza, 2014; Herold, et al., 2012) and quality (Azemi, 2013; Boucher et al., 2013; Forsey, et al., 2013; Hoffman, 2014) of in-class discussion increased. For example, Boucher et al. (2013) observed that higher-level reasoning was evident during in-class discussions, because students were not exposed to

content for the first time in class. Students in two studies claimed that in-class discussion enhanced their learning (Gaughan, 2014; McLaughlin et al., 2014) and in four studies, students claimed to participate more (Arnold-Garza, 2014; Gaughan, 2014; Herold, et al., 2012; McLaughlin et al., 2014).

2.4.5 Attitudes towards Instructor Interaction

Six studies noted increased opportunities for interaction between individual students and the instructor with the flipped classroom approach (Gannod, et al., 2008; Gaughan, 2014; Lage, et al, 2000; Pierce & Fox, 2012; Slomanson, 2014; Van Veen, 2013). Van Veen (2013) observed direct interaction between the instructor and each student group at least once or twice during each class session. The instructor claimed that he was able to get to know the students better in a flipped classroom than with a lecture-based approach (Van Veen, 2013). Students in three studies noted that the role of the instructor had changed and they agreed that the instructor was there to help them (Frydenberg, 2013; Gannod, et al., 2008; McGivney-Burelle & Xue, 2013). Students in four studies reported that they appreciated being able to ask questions and receive feedback in class (Butt, 2014; Gannod, et al., 2008; McGivney-Burelle & Xue, 2013; Yeung & O'Malley, 2014) and instructors in two studies reported that they were better able to assess student understanding and correct misconceptions during in-class activities (Critz & Knight, 2013; Enfield, 2013). Amiri et al. (2013) reported that 70% of students surveyed agreed that the flipped classroom strengthened the relationship between students and instructors, however, in two studies, student evaluations of instructor performance using the flipped classroom approach did not differ significantly from traditional approaches (Davies, et al., 2013; Van Veen, 2013).

2.4.6 Attitudes towards Video/Multimedia

Eleven studies found that students believed that engaging with online video content before class prepared them for enhanced learning in class (Boucher, et al., 2013; Critz & Knight, 2013; Forsey, et al., 2013; Gaughan, 2014; Guerrero, et al., 2013; McGivney-Burelle & Xue, 2013; McLaughlin et al., 2013; McLaughlin et al., 2014; Slomanson, 2014; Toto & Nguyen, 2009; Yeung & O'Malley, 2014). When McLaughlin (2014) asked students about the benefits of interactive on-line video, 90% indicated that they helped them prepare for each class session (McLaughlin et al., 2014). Students also reported that they were better able to participate in class discussions (Gaughan, 2014) and hands-on work in class (Toto & Nguyen, 2009). They liked seeing a clear overview of the content before class (Forsey, et al., 2013; Guerrero, et al., 2013; McGivney-Burelle & Xue, 2013) and being able to come to class with questions (Guerrero, et al., 2013).

Six studies noted that students appreciated the flexibility of accessing online video and other multimedia when and where they chose (Amiri, et al., 2013; Boucher, et al., 2013; Forsey, et al., 2013; Guerrero, et al., 2013; Lucke, et al., 2013; Yeung & O'Malley, 2014). Students in eight studies appreciated being able to work through the content at their own pace (Davies, et al., 2013; Guerrero, et al., 2013; Larson & Yamamoto, 2013; McGivney-Burelle & Xue, 2013; McLaughlin et al., 2013; McLaughlin et al., 2014; Taylor, et al., 2012; Yeung & O'Malley, 2014). Nine studies reported that students thought videos and multimedia were helpful for reviewing content before exams or as a reference for an assignment (Amiri, et al., 2013; Boucher, et al., 2013; Gannod, et al., 2008; Guerrero, et al., 2013; Mason, et al., 2013a; McGivney-Burelle & Xue, 2013; McLaughlin et al., 2014; Slomanson, 2014; Tune, et al., 2013). Gannod, Burge, and Helmick, (2008) found that most

students in their study believed that certain topics were not well suited for instruction in online videos format. These students suggested that online videos should be used to supplement rather than replace in-class lectures (Gannod, et al., 2008).

Alternatively, Strayer (2012) found that some flipped classroom students struggled to connect pre-class learning to in-class activities, because the content was sometimes explained differently in the online eTutoring system being used.

Nine studies advocated limiting the length of on-line videos and multimedia presentations in order to encourage student engagement (Azemi, 2013; Critz & Knight, 2013; Gaughan, 2014; Guerrero, et al., 2013; Kellogg, 2009; Schwartz, 2014; Slomanson, 2014; Toto & Nguyen, 2009; Van Veen, 2013). Limits suggested included under 10 minutes (Guerrero, et al., 2013; Slomanson, 2014), between 10 and 15 minutes (Gaughan, 2014; Schwartz, 2014), or between 20 and 30 minutes (Azemi, 2013; Critz & Knight, 2013; Toto & Nguyen, 2009; Van Veen, 2013). Some students had negative attitudes towards longer videos (Amresh, et al., 2013; Boucher, et al., 2013; Gaughan, 2014). Enfield (2013) found that 65% of students felt that 20 minute videos were appropriate whereas 32% felt they were too long.

2.4.7 Perceptions of Workload

Twelve studies examined student perceptions of the workload required by the flipped classroom approach with mixed results.

In two studies, students felt that the flipped classroom format helped them save time and learn more quickly than traditional approaches (Amiri, et al., 2013; Bijlani, et al., 2013). This was supported by Mason, Shuman, and Cook (2013a; 2013b), who found that students

in the flipped classroom reported spending significantly less time studying than students in the traditional approach.

Three studies reported that the majority of students thought that the amount of homework with the flipped classroom approach was appropriate (Critz & Knight, 2013; Enfield, 2013; Van Veen, 2013). This is supported by Herold, Lynch, Ramnath, and Ramanathan (2012), who reported that the amount of studying required by flipped course was similar to that of a comparable non-flipped course.

Four studies noted that students believed that the flipped classroom approach increased their workload overall (Davis & Minifie, 2013; Findlay-Thompson & Mombourquette, 2014; Forsey, et al., 2013; Tune, 2013). A minority of students in three studies indicated the amount of homework was excessive (Critz & Knight, 2013; Enfield, 2013; Van Veen, 2013). Enfield (2013) reported that the bottom performing students were more likely to feel that the amount of homework was too much.

The variation on this issue suggests that the impact on student workload should be a design consideration when implementing the flipped classroom approach.

2.5 Student Behaviours

Twenty-nine studies reported observations of student behaviour in the flipped classroom. Two major themes were evident: engagement and preparation for class. Each of these will be discussed in turn.

2.5.1 Engagement

Six studies reported that student attendance was higher in the flipped classroom than in the traditional classroom (Butt, 2014; Forsey, et al., 2013; Gaughan, 2014; Lucke, et al., 2013; McLaughlin et al., 2014; Sales, 2013). Thirteen studies found that student

engagement in class increased substantially with the flipped classroom approach (Azemi, 2013; Critz & Knight, 2013; Enfield, 2013; Frydenberg, 2013; Gannod, et al., 2008; Gaughan, 2014; Hoffman, 2014; Lasry, et al., 2014; Lucke, et al., 2013; McLaughlin et al., 2013; McLaughlin et al., 2014; Ryan, 2013; Strayer, 2012). Seven studies reported that the flipped classroom approach had a positive impact on student motivation (Amiri, et al., 2013; Lage, et al, 2000), particularly when routine quizzes were implemented (Enfield, 2013; Frydenberg, 2013; Herold, et al., 2012; Tune, et al., 2013; Wilson, 2013). On the other hand, Schwartz (2014) found that students only slightly agreed that the flipped classroom made the course more interesting and Yeung (2014) reported that some students found live lectures more engaging.

2.5.2 Preparation for Class

Students from two studies agreed that preparation for class was necessary to be successful in a flipped classroom (McLaughlin et al., 2014; Pierce & Fox, 2012). Twelve studies reported that the majority of students completed the pre-class learning activities prior to coming to class (Arnold-Garza, 2014; Gaughan, 2014; Lasry, et al., 2014; Mason, et al., 2013a; McGivney-Burelle & Xue, 2013; McLaughlin et al., 2013; McLaughlin et al., 2014; Pierce & Fox, 2012; Sadaghiani, 2012; Slomanson, 2014; Tune, et al., 2013; Van Veen, 2013). Instructors noted that students came to class with meaningful questions (Hoffman, 2014), were more aware of the content being covered (Guerrero, et al., 2013), and were better able to articulate concepts in class (Slomanson, 2014). Sales (2013) found that 70% of the students prepared for the first flipped classroom training session, but student preparation increased to 90% by the next session. Alternatively, Strayer (2012) found that

completing homework was not a priority for his students in either the flipped classroom or traditional courses.

Some students claimed that in-class activities were hamstrung by students who had not studied the relevant materials (Butt, 2014). Schwartz (2014) contended that students would recognize the need to prepare once they started to lag behind their peers during in-class activities.

2.6 Impact on Student Performance

2.6.1 Overview

Almost one third of the selected studies (n = 15, 33%) analysed student grades between the flipped classroom and traditional approaches. Eight of these studies (53%) reported statistically significant gains in favour of flipped classrooms over conventional classrooms (Ferreri & O'Connor, 2013; Mason, et al., 2013a; McLaughlin et al., 2014; Missildine, Fountain, Summers, & Gosselin, 2013; Pierce & Fox, 2012; Talley & Scherer, 2013; Tune, et al., 2013; Wilson, 2013) whereas seven (44%) noted no statistical difference (Davies, et al., 2013; Findlay-Thompson & Mombourquette, 2014; Guerrero, et al., 2013; Larson & Yamamoto, 2013; Love, et al., 2014; Mason, et al., 2013b; McLaughlin et al., 2013). In addition, two of the selected studies (4 %) reported a change in the distribution of student grades that resulted in an anecdotal increase in the success rate of students in the flipped classroom compared to traditional approaches (Boucher, et al., 2013; Van Veen, 2013).

No consistent theme was evident that might explain why certain studies found a positive impact on student grades and others showed no impact. Of note is that none of the selected studies reported lower grades with the flipped classroom approach. Details of

studies that reported significant gains in student performance, no significant difference in student performance, and increased student success rates will be discussed in turn.

2.6.2 Significant Gains in Student Performance

Wilson (2013) examined the performance of undergraduate social science majors taking an introductory statistics course using pre/post-test scores, exam grades, and final grades. She found that while there was no difference in pre-test scores between students enrolled in flipped classroom sections and traditional sections, that post-test scores were significantly higher for the flipped classroom students (Wilson, 2013). Wilson (2013) also reported that exam grades were significantly higher in sections taught using the flipped classroom approach. Although Wilson (2013) reported that overall grades were significantly higher in the flipped classroom sections, she also pointed out that the way that grades were assigned was different between approaches. Ferreri and O'Connor (2013) noted significant improvements in student final grades in the both the first (n = 152) and second (n = 151) years of implementing a flipped classroom approach in large undergraduate pharmacy course, compared to final grades in the course before it was redesigned (n = 146). However, like Wilson (2013), the method for calculating grades changed with the redesign of the course (Ferreri & O'Connor, 2013).

Missildine et al. (2013) examined 589 exam grades for undergraduate nursing students taking adult health courses. They determined that the scores were significantly higher for students who experienced the flipped classroom approach compared to students taking the same courses using either a traditional lecture-only approach, or a lecture-based approach supplemented with on-line videos (Missildine, et al., 2013). Talley and Scherer (2013) compared final grades in two sections of an undergraduate psychology course. One

section was taught in a conventional format along with supplemental on-line videos, and the other was taught using a flipped classroom approach including active learning activities. Student performance in the flipped classroom section was significantly higher than the section taught using the conventional approach (Talley & Scherer, 2013).

Tune, Sturek, and Basile (2013) found that graduate students taking physiology courses using the flipped classroom approach scored significantly higher on the cardiovascular, respiratory, and weighted cumulative sections of the final exam compared to students taking the same courses using a traditional lecture-based approach. Pierce and Fox (2012) reported that undergraduate pharmacy students' performance on exam questions relating to a module that was taught using a flipped classroom approach was significantly higher than the performance of students who completed the same module in a traditional classroom setting.

McLaughlin et al (2014) noted that final exam grades were significantly higher for students taking an undergraduate pharmacy course using the flipped classroom approach compared to those that took the course in a traditional format the year before, but this was not the case for students taking the course from satellite campuses via video teleconference (McLaughlin et al, 2013).

2.6.3 No Significant Differences in Student Performance

Mason, Shuman, and Cook, (2013a) examined student performance in flipped classroom and traditional approach offerings of an undergraduate mechanical engineering course taught in different years. They found that on exams and quizzes, students in the flipped classroom scored significantly higher on three of five problem types as well as on design problems (Mason, et al., 2013a). However, when they subsequently considered data

from an additional flipped classroom year, they found that exam and quiz scores aggregated by general topic area did not significantly differ from one year to another (Mason, et al., 2013b).

Findlay-Thompson and Mombourquette (2014) compared final grades between undergraduate students taking an introduction to business course using the flipped classroom approach and similar students taking the same course in traditional lecture-based approach and found no difference, despite some of the students from the flipped classroom section indicating that they believed they had earned better grades.

Davies, Dean, and Ball (2013) found that grades for undergraduate students taught spreadsheet skills using the flipped classroom approach were significantly higher than the grades earned by students taught using simulation software, but not significantly different than those students taught using a lecture-based approach. Larson and Yamamoto (2013) found that differences in assignment grades between undergraduate students taking a spreadsheet course using the flipped classroom and traditional lecture-based approaches were not statistically significant.

Love, Hodge, Grandgenett, and Swift (2014) analysed final exam scores for undergraduate students taking a linear algebra course. They found no statistical differences in scores between those students that took the course using the flipped classroom approach and those that took the course in a lecture-based format. Guerrero, Baumgartel, and Zobott (2013) reported that pre-service teachers taking a mathematics course in the flipped classroom format had a greater mean difference and a greater range of differences in pretest/post-test scores compared to pre-service teachers taking the

course using the traditional approach, but that these differences were not statistically significant.

2.6.4 Increased Student Success Rates

Two studies noted that the flipped classroom approach reduced the number of students who received low grades (Boucher, et al., 2013; Van Veen, 2013). Boucher, Robertson, Wainner, and Sanders (2013) found that none of the students taking musculoskeletal curriculum in a Doctor of Physical Therapy program using the flipped classroom approach failed the practical exam. They reported, anecdotally, that this result was atypical in their experience (Boucher, et al., 2013). Van Veen (2013) reported that 90% of the undergraduate engineering students taking a signals processing course using the flipped classroom approach had a final exam score of above 70/100, compared to only 55% of the students taking the same course using the conventional approach.

2.7 Gaps in the Research

In the current literature, the flipped classroom is almost always contrasted with lecture-based approach. Twenty articles (41%) compare a flipped classroom treatment group to an implementation of at least one different teaching approach (Appendix A). All but one of these articles (95%) compared a flipped classroom to what was often described as the traditional approach, featuring didactic lecture as the primary teaching activity. The control group of the remaining study (Guerrero, et al., 2013) featured active-learning elements alongside lecture. Davies, Dean and Ball's (2013) study was unique in that it compared three teaching approaches: the flipped classroom, a simulation-based approach, and a lectured-based approach.

Much of what has been reported about the flipped classroom is similar to what has been written about active learning strategies; namely, that active learning is engaging (Bonwell & Eison, 1991; Davis & Minifie, 2013; Grant 2013) and promotes positive student attitudes and achievement (Bonwell, 1996; Bonwell & Eison, 1991; Davis & Minifie, 2013). It is not clear, however, whether the various advantages are attributed to the flipped classroom approach *per se*, or if they are advantages one might expect to see if any well-considered active learning approach was implemented. Direct comparisons between the flipped classroom approach and non-flipped active learning have yet to be systematically investigated.

Another issue is that the current literature on flipped classrooms has focused entirely on university students. Thirty-seven articles (76%) studied undergraduate students exclusively, 7 articles (14%) studied graduate students exclusively, and 5 articles (10%) studied both undergraduate and graduate students (Appendix A). None of the articles studied participants pursuing a community college certificate or diploma. One might speculate that the flipped classroom would impact a college student and a university student in similar ways, but there is no clear evidence that this is the case. Ertmer and Newby (2013) point out that different instructional strategies are appropriate depending on the nature of what must be learned and how advanced learners are with the subject currently. Community college programming tends to focus on job-oriented, practical skills training compared to universities, which focus more on academic and professional programs. The flipped classroom approach might be more or less suited for use in the community college environment based on the applied nature of the curriculum and the unique aptitudes of college students.

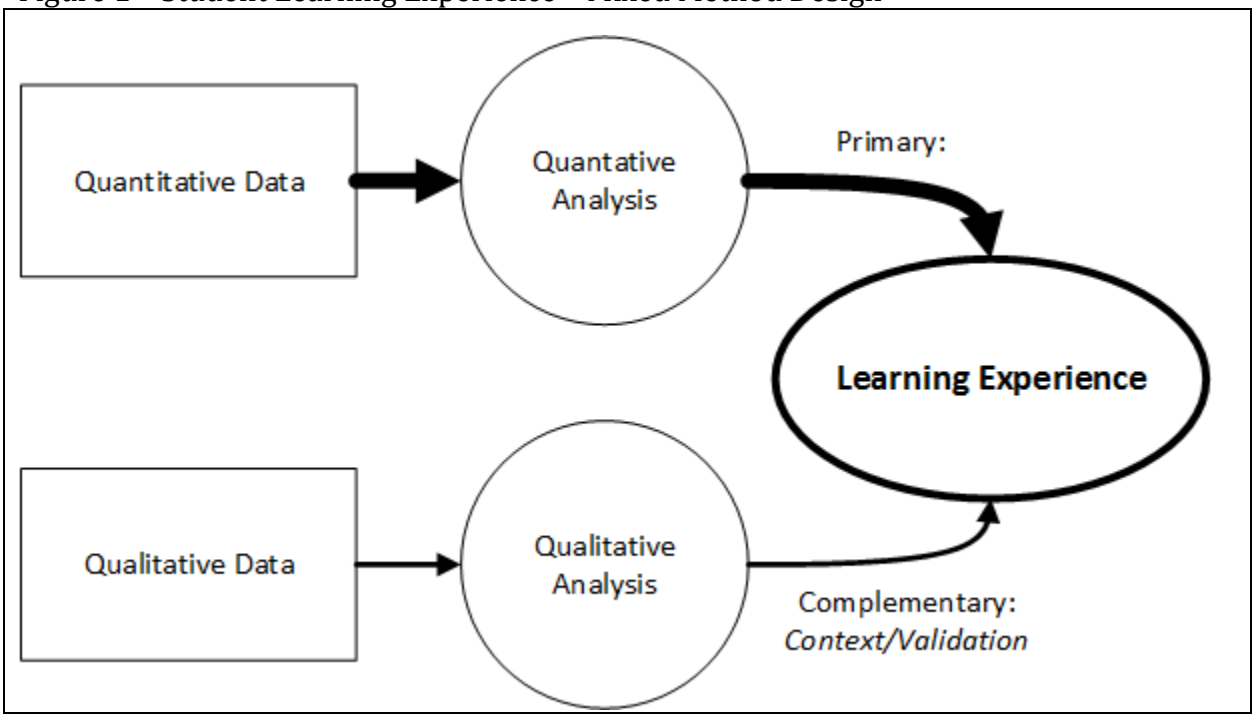
Community colleges are major component of postsecondary education in Canada, representing over a third of postsecondary enrollments (Statistics Canada, 2014). The highest educational credential earned by 21% of Canadian adults is a college certificate or diploma compared to 26% that earned a university credential at bachelor degree level or above (Statistics Canada, 2015). The lack of study aimed at this segment of postsecondary education represents a significant research opportunity.

3 Method

3.1 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. Convergent parallel mixed method design refers to collecting quantitative and qualitative data concurrently, analysing each type of data separately, and merging the results into a singular interpretation (Creswell & Plano Clark, 2011). This methodological design was selected because it was felt that comparing and contrasting quantitative results with qualitative results would result in a more complete understanding of how the flipped classroom approach impacts students in relation to other approaches. Quantitative and qualitative data were collected at multiple points during the study. Quantitative data consisted of Likert-scale survey question responses and on-line quiz grades. Qualitative data consisted of open-ended survey question responses. The quantitative data served as the primary basis to measure the student learning experience and student performance, and qualitative data was used to provide context and explain the quantitative findings (Figure 1).

Figure 1 – Student Learning Experience – Mixed Method Design



3.2 Sample Description

Convenience sampling was used in this study. Volunteers were recruited from three sections (n = 103) of a second-semester computer programming course taught by the researcher 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 4).

Table 4 – 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 5).

Table 5 – 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 6).

Table 6 – 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.	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.

3.3 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 7 – 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	75.0% (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 course 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 8).

Table 8 – 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 9). 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 9 – 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

3.4 Data Collection Instruments

3.4.1 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 (Appendix C, 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 this information.

3.4.2 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 (Appendix C, 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 (Appendix C, Question 9).

Both the participant demographics and culture of learning questions which participants answered at the beginning of the study were developed over several iterations of draft revision and expert review. It should be noted that they were not piloted before their use in this study.

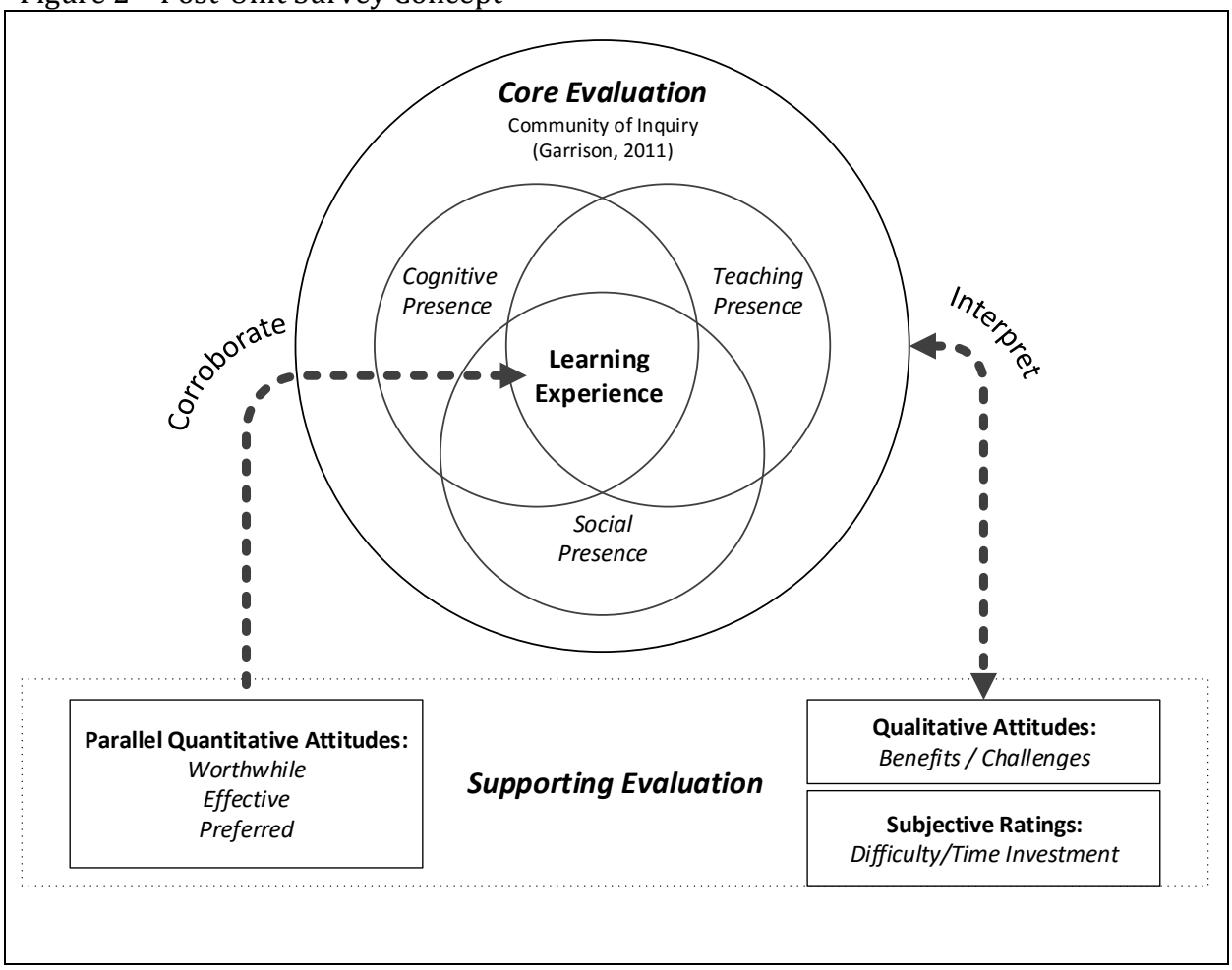
3.4.3 Student Learning Experience

Post-unit surveys were developed to solicit quantitative and qualitative data evaluating the student learning experience with each of the three teaching strategies used. Like the participant demographics and culture of learning survey questions, the post-unit survey questions were developed over several iterations of draft revision and expert review, and were also not piloted before their use in this study. The post-unit surveys included four conceptual elements: a core evaluation of the learning experience based on the Community of Inquiry (Garrison, 2011) framework (Appendix D, Questions 1 to 23), quantitative measurement of parallel student attitudes to validate the core evaluation (Appendix D, Questions 28 to 31), qualitative student attitudes about benefits and challenges (Appendix D, Questions 32 to 33), and subjective ratings of difficulty and time investment (Appendix D, 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



3.4.3.1 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).

3.4.3.2 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* (Appendix D, Questions 1 to 10), *social presence* (Appendix D, Questions 11 to 16), and *cognitive presence* (Appendix D, 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 10).

Table 10 – 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

3.4.3.3 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 (Appendix D, 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).

3.4.3.4 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 11) (Appendix D, Questions 24 to 27).

Table 11 – Difficulty and Time Investment

Category	Items	Range	Type Scale
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

3.4.3.5 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 (Appendix D, 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 12). Refer to Appendix E for detailed descriptions of each theme.

Table 12 – 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

3.4.4 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 13). 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 13 – 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

3.4.5 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 14 describes each variable collected.

Table 14 – 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 have watched the videos.
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.

3.5 Procedure

3.5.1 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 (Appendix B) that 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.

3.5.2 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.

3.5.2.1 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.

3.5.2.2 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.

3.5.2.3 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.

3.5.2.4 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

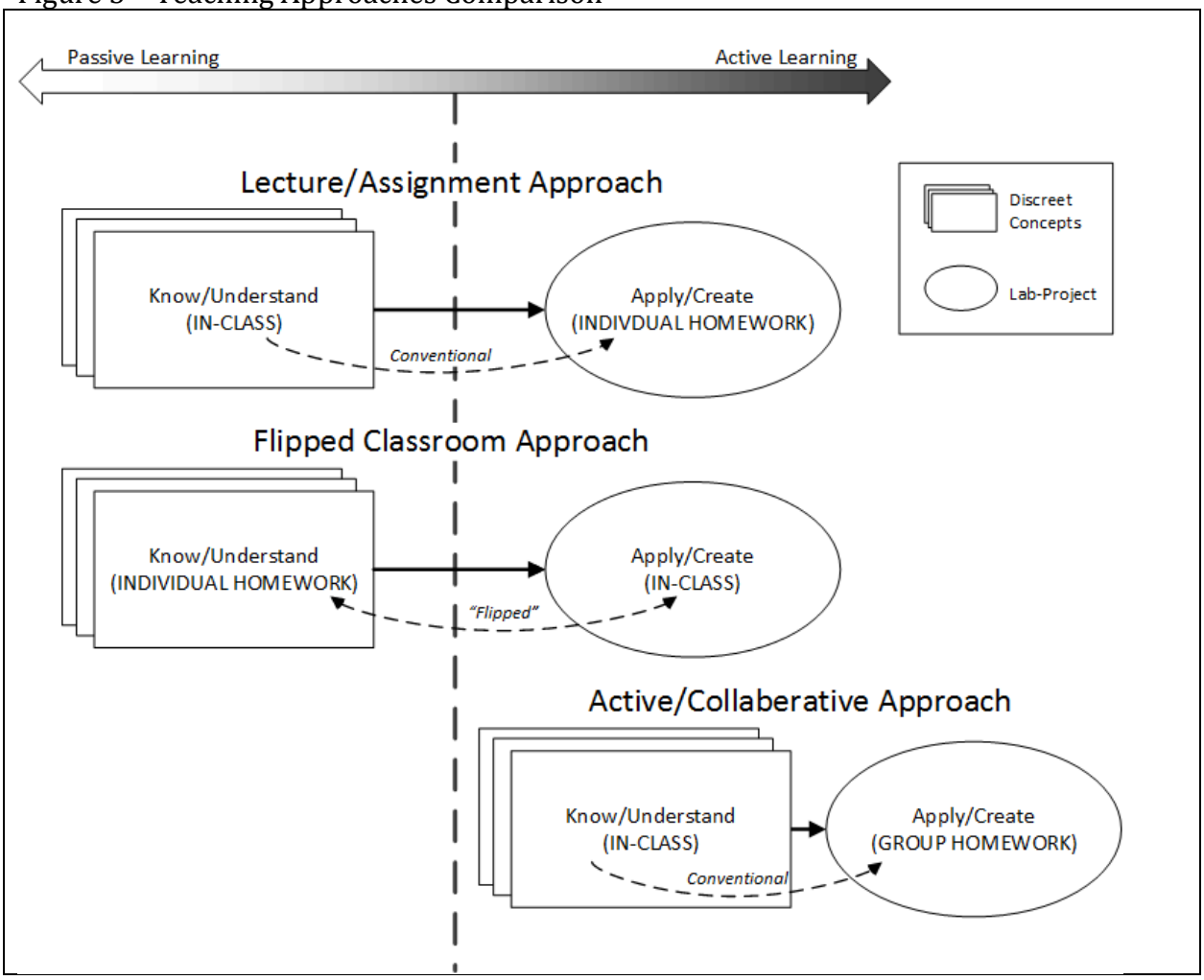


Table 15 summarizes how each teaching approach addresses the need to know and understand concepts and the need to apply concepts and create solutions.

Table 15 – 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.

3.5.3 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 (Appendix C).

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 (Appendix D). 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 (Appendix D). 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 (Appendix D).

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 (Appendix D). 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 (Appendix D). 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 (Appendix D).

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 16).

Table 16 – 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

3.6 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 17 provides a summary of the data sources and analyses used to examine each research question.

Table 17 – 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

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	*SD*	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	*df*	Sum of Squares	Mean Square	*F*
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	*SD*	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	*df*	Sum of Squares	Mean Square	*F*
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	n	Mean	*SD*	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	*df*	Sum of Squares	Mean Square	*F*
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	*SD*	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	*df*	Sum of Squares	Mean Square	*F*
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	*SD*	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)

	Lecture		Active		Flipped	
Theme	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	Lecture		Active		Flipped	
Theme	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	*df*	Sum of Squares	Mean Square	*F*
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	Lecture		Active		Flipped	
Theme	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 difficultly 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	*df*	Sum of Squares	Mean Square	*F*
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	Lecture		Active		Flipped	
Theme	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*).

5 Discussion

5.1 Overview

The purpose of this study was to explore the flipped classroom approach in a community college setting. Unlike previous studies that contrasted flipped classroom implementations with traditional lecture-based approaches, this study sought to compare the flipped classroom to both lecture-based and active/collaborative learning approaches. This study assessed the overall learning experience afforded by each approach, the impact each approach had on student perceptions of cognitive, teaching, and social presence, and finally the impact each approach had on student performance.

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

In this study, students rated the overall learning experience of each approach on the total core evaluation scale, which was based on all three main elements of Garrison's (2011) Community of Inquiry framework. Students rated both the flipped classroom approach and the active/collaborative approach significantly higher than the lecture/assignment approach. This result matches numerous studies that reported positive student ratings of the flipped classroom compared to traditional approaches (Arnold-Garza, 2014; Butt, 2014; Enfield, 2013; Gannod, et al., 2008; Guerrero, et al., 2013; Hoffman, 2014; Lage, et al, 2000; Love, Hodge, Grandgenett, & Swift, 2014; McGivney-Burelle & Xue, 2013; Schwartz, 2014; Taylor, et al., 2012; Van Veen, 2013) as well as studies that contended that active learning improves student attitudes (Bonwell, 1996; Bonwell & Eison, 1991; Davis & Minifie, 2013; Lou et al., 1996).

Students in this study also rated each teaching approach on the parallel attitudes scale, which included overall ratings of how worthwhile the learning activities were, how

effective they found the approach, and whether this was their preferred approach. On this scale, students rated the active/collaborative approach significantly higher than the lecture/assignment approach, which was supported by the qualitative comments that students made about each teaching approach overall. This result is congruous with previous studies that link active and collaborative learning to positive student attitudes (Bonwell, 1996; Bonwell & Eison, 1991; Davis & Minifie, 2013; Grant, 2013; Järvelä, Volet, & Järvenoja, 2010; Laal & Laal, 2012; Lou et al., 1996; Michael, 2006).

Of note is that the flipped classroom approach was not significantly different than the lecture-based approach on the parallel attitudes scale. Qualitative comments regarding flipped teaching generally indicated that it was not an effective approach for some students. This is consistent with a minority of previous studies that reported that some students preferred lecture-based teaching (Arnold-Garza, 2014; Findlay-Thompson & Mombourquette, 2014; Guerrero, et al., 2013; Larson & Yamamoto, 2013, Van Veen, 2013) and that some students had negative attitudes towards the learning activities of the flipped classroom approach (Amresh, et al., 2013; Butt, 2014; Enfield, 2013; Larson & Yamamoto, 2013), or flipped teaching generally (Amresh, et al., 2013; Missildine, et al., 2013; Strayer, 2012; Tune, et al., 2013).

There are a number of potential reasons as to why the students in this study did not rate the flipped classroom approach as highly as students in most other studies. With respect to cognitive presence, several students in this study found that applying concepts to practical problems in class was difficult. Also, students in this study may not have found that the flipped classroom approach was engaging. Concerning teaching presence, some students in this study had difficulty finding the time to watch the required videos before

class. Regarding social presence, some students in this study disliked group-work. Each of these potential reasons is discussed in further detail in the sections that follow.

5.3 Perceptions of Cognitive Presence

There were no significant differences in student ratings of cognitive presence among the flipped classroom approach, the lecture/assignment approach, and the active/collaborative approach in this study. However, the volume of students' open-ended comments relating to application of concepts and student engagement suggest that there were qualitative distinctions among the approaches. Each of these areas will be discussed in turn.

5.3.1 Application of Concepts

It was suggested in the literature that lectures alone may not be effective for deep understanding or for developing practical skills (Bligh, 2000; Bonwell, 1996; Cashin, 1985; Charlton, 2006). Pairing lectures with other learning activities is common (Bligh, 2000; Brown & Race, 2005; Cashin, 1985). Several students who commented on the lecture/assignment approach in this study noted that the lecture was helpful for completing the practical homework assignment. This may suggest that pairing lectures with practical homework assignments can be an effective approach in terms of enabling college students to apply programming concepts.

Students in this study rated the out-of-class activities for the active/collaborative approach as significantly less difficult than the other approaches, which was reinforced by many students' open-ended comments. This is consistent with other studies that contend that active learning techniques are effective for developing problem-solving skills (Bonwell, 1996; Bonwell & Eison, 1991; Davis & Minifie, 2013; Grant, 2013; Laal & Laal, 2012). A few

students in this study were critical of the active/collaborative approach in terms of the time pressure they felt in completing activities in-class, which is in line with the literature that suggests active/collaborative learning can be less time-efficient than lecture-based approaches (Bishop, & Verleger, 2013a; Bishop, & Verleger, 2013b, Bonwell & Eison, 1991; Davis & Minifie, 2013; Lage, et al, 2000). However, a majority of students rated the amount of time allocated to learning activities in the classroom for the active/collaborative approach units as "About Right."

Several students, commenting on the flipped classroom approach in this study, experienced considerable difficulty applying the concepts from the pre-class videos to the practical problems in class, contrary to the results of many other studies (Boucher, et al., 2013; Critz & Knight, 2013; Forsey, et al., 2013; Gaughan, 2014; Guerrero, et al., 2013; McGivney-Burelle & Xue, 2013; McLaughlin et al., 2013; McLaughlin et al., 2014; Slomanson, 2014; Toto & Nguyen, 2009; Yeung & O'Malley, 2014).

One might speculate that this discrepancy is due to issues with the effectiveness of the videos in this study, however, students reported that the videos were an effective way for them to learn basic concepts. Like other studies, students reported that being able to re-watch videos and move through content at their own pace helped their understanding (Davies, et al., 2013; Guerrero, et al., 2013; Larson & Yamamoto, 2013; McGivney-Burelle & Xue, 2013; McLaughlin et al., 2013; McLaughlin et al., 2014; Taylor, et al., 2012; Yeung & O'Malley, 2014). Alternatively, it is possible that a number of students in this study did not watch the pre-class videos. The audience view and retention data suggests that majority of students did watch videos, just as students in several other studies did (Arnold-Garza, 2014; Gaughan, 2014; Lasry, et al., 2014; Mason, et al., 2013a; McGivney-Burelle & Xue,

2013; McLaughlin et al., 2013; McLaughlin et al., 2014; Pierce & Fox, 2012; Sadaghiani, 2012; Slomanson, 2014; Tune, et al., 2013; Van Veen, 2013). However, a sizable minority of the students in this study did not watch the pre-class videos which may account for some of the difficulty encountered in class.

Another reason why students in this study had difficulty applying concepts might stem from the nature of the in-class problems used in the flipped classroom approach. In the active/collaborative approach, in-class activities tended to be short, highly structured, and instructor-led. Students solved more complicated problems outside of the rigid time-limitations of the in-class session. In contrast, the in-class exercises of the flipped classroom tended to be longer, less well-defined, and minimally guided. It may have been that this form of in-class problem as ill-suited for first year community college students. Although this explanation is speculation, it fits with studies that reported that the flipped classroom approach was not suitable for first year classes (Mason, et al., 2013a; Yeung & O'Malley, 2014), as well as evidence that suggested that minimal guidance approaches are less effective than techniques featuring explicit instructor guidance (Kirschner, et al., 2006).

5.3.2 Student Engagement

Many of the students in this study remarked that the lecture component of the lecture/assignment approach did not hold their attention, which is supported by Cashin's (1985) assertion that the students' attention can wane quickly in a lecture. In contrast, students in the study found that the active/collaborative approach sustained their attention effectively, which is aligned with other studies that report that

active/collaborative learning increases student interest and engagement (Bonwell & Eison, 1991; Davis & Minifie, 2013; Grant 2013; Laal & Laal, 2012).

Student engagement was expected to be high in the flipped classroom approach based on the results of several other studies (Azemi, 2013; Critz & Knight, 2013; Enfield, 2013; Frydenberg, 2013; Gannod, et al., 2008; Gaughan, 2014; Hoffman, 2014; Lasry, et al., 2014; Lucke, et al., 2013; McLaughlin et al., 2013; McLaughlin et al., 2014; Ryan, 2013; Strayer, 2012), but there was little evidence of this in the students' open-ended survey comments.

One possible factor that may be contributing to this discrepancy is that the students in this study were community college students, who are typically more focused on practical skills rather than theoretical concepts. It stands to reason that these students, who found that in-class lectures were boring, would find that watching online videos passively was no more engaging. Another possible factor that may have reduced student engagement in the flipped classroom was that the course content was computer programming, which is essentially applied problem-solving. It might be that the students felt that watching videos about programming concepts was not relevant to their learning goals. Another potential factor was that students in this study that reported having difficulty applying concepts may have felt disengaged as a result.

5.4 Perceptions of Teaching Presence

In this study, there were no significant differences in the student ratings of teaching presence in the flipped classroom approach when compared to either the lecture/assignment approach or the active/collaborative approach. However, the active/collaborative approach had a significantly higher student rating of teaching presence than the lecture/assignment approach. The students' qualitative responses

suggested that teaching presence was most evident in the availability of timely guidance and feedback for both the active/collaborative approach and the flipped classroom approach. In the lecture/assignment approach, teaching presence was predominately about the clarity and amount of detail furnished by direct instruction. Students also commented on the flexibility in the time and place of instruction with the flipped classroom approach. Each of these will be discussed in turn.

5.4.1 Availability of Timely Guidance and Feedback

One aspect of teaching presence which was similar in both the flipped classroom and active/collaborative approach was that students appreciated that guidance and feedback was available immediately in the classroom. This aligns with flipped classroom researchers that reported more frequent interaction between individual students and the instructor (Gannod, et al., 2008; Gaughan, 2014; Lage, et al, 2000; Pierce & Fox, 2012; Slomanson, 2014; Van Veen, 2013), that students recognized that the role of the instructor in the classroom was to provide support (Frydenberg, 2013; Gannod, et al., 2008; McGivney-Burelle & Xue, 2013), and that students liked being able to ask questions and receive feedback in class (Butt, 2014; Gannod, et al., 2008; McGivney-Burelle & Xue, 2013; Yeung & O'Malley, 2014). With regard to the lecture/assignment approach, students also valued the ability to ask questions and receive an immediate answer during a live lecture, but some noted difficulty resolving questions related to the homework assignment.

5.4.2 Clarity and Amount of Detail of Direct Instruction

Anecdotally, teaching presence in lecture/assignment approach was evident in terms direct instruction. Students in this study appreciated the clarity of the lectures, the amount of detail they covered, and that they signalled what content was most important for them to

understand. Each of these observations is aligned with advantages of lecture-based teaching reported in literature (Bligh, 2000; Brown & Race, 2005; Cashin, 1985; Charlton, 2006; Kirschner, Sweller, & Clark, 2006; Race, 2007). Alternatively, there were very few student comments that addressed direct instruction with regard to the active/collaborative or flipped classroom approaches.

5.4.3 Flexibility in the Time and Place of Instruction

A small number of students in this study reported that a benefit of the flipped classroom approach was being able to watch on-line videos when and where it was convenient for them. This sentiment was also reported by a number of other studies (Amiri, et al., 2013; Boucher, et al., 2013; Forsey, et al., 2013; Guerrero, et al., 2013; Lucke, et al., 2013; Yeung & O'Malley, 2014). However, other students in this study indicated that it was difficult to find the time to watch videos before class. One possible explanation is that it may have been harder for some students to establish a consistent study/homework routine because the teaching approach changed each time they started a new unit. While this is just speculation, a number of other studies have noted that students need to adjust their study habits with the flipped classroom approach (Guerrero, et al., 2013; Mason, et al., 2013a; Strayer, 2012). Another possible explanation is that, as discussed previously, college students may not find that watching videos about concepts is relevant to learning a practical skill, so finding the time to watch them before class is not a high priority.

5.5 Perceptions of Social Presence

In this study, the flipped classroom and the active/collaborative approaches showed significantly higher social presence than the conventional lecture/assignment approach.

The strength of the flipped classroom approach regarding social presence appears to stem from the students' appreciation for working with one another in class. In contrast, the lecture/assignment approach in this study did not have a group work component. This is aligned with the current literature which suggests that working collaboratively with peers in class is a positive feature of the flipped classroom (Amiri, et al., 2013; Ferreri & O'Connor, 2013; Frydenberg, 2013; Lage, et al, 2000; Love, et al., 2014; Ryan, 2013; Strayer, 2012).

A small number of students in this study noted negative feelings about the group work requirement of the flipped classroom. Ryan (2013) reported a similar sentiment; that some students had negative attitudes about group-work in the flipped classroom because they were concerned that grade assignment would not be equitable and that individual effort would not be recognized appropriately.

Moderately improved student perception of social presence was also observed when comparing the active/collaborative approach to the lecture/assignment approach. Like the flipped classroom approach, students worked collaboratively in class, however, several students had difficulty keeping pace in class with their peers, or found that pausing activities to help students having difficulty was disruptive. This is likely due to the fact that more of the activities in the active/collaborative classes were guided by the instructor than in the flipped classroom. Despite this, the mean social presence score for active/collaborative approach and flipped classroom approach were not significantly different.

5.6 Student Performance

In this study, quiz grades were used to measure student performance for each of the three teaching approaches. There were no significant differences in quiz grades among the flipped classroom approach, the lecture/assignment approach, and the active/collaborative approach. In the current literature, the impact of the flipped classroom approach student performance is mixed with many researchers reporting significant positive gains (Ferreri & O'Connor, 2013; Mason, et al., 2013a; McLaughlin et al., 2014; Missildine, Fountain, Summers, & Gosselin, 2013; Pierce & Fox, 2012; Talley & Scherer, 2013; Tune, et al., 2013; Wilson, 2013), and other researchers reporting no significant differences (Davies, et al., 2013; Findlay-Thompson & Mombourquette, 2014; Guerrero, et al., 2013; Larson & Yamamoto, 2013; Love, et al., 2014; Mason, et al., 2013b; McLaughlin et al., 2013). This study aligns with the latter group.

Of note is that the quizzes examined in this study focussed on the student's basic comprehension of unit content. The students' ability to analyse requirements and apply concepts in the context of a problem was evaluated, but these grades were calculated differently for each teaching approach, so direct comparisons were not valid. Differences in the method used for calculating grades after implementing a flipped classroom were also found in the literature (Ferreri & O'Connor, 2013; Wilson 2013). With this in mind, lack of a significant difference in quiz grades between the active/collaborative approach and the lecture/assignment approach is aligned with other studies that suggest active learning and lecture-based techniques are comparable for learning content knowledge (Bonwell & Eison, 1991; Grant 2013).

The lack of a significant difference in quiz grades between the flipped classroom approach and the lecture/assignment approach might have a similar explanation. It may be possible that the flipped classroom approach is comparable to lecture for learning content knowledge, but could result in superior student performance when assessing problem-solving and higher order thinking skills, like active learning generally (Bonwell, 1996; Bonwell & Eison, 1991, Davis & Minifie, 2013). This study does not answer this question however.

5.7 Limitations and Future Research

5.7.1 Overview

Careful attention was paid to measures designed to ensure the quality of this study. For example, a thorough description of the participants including their disposition towards certain learning activities was established to provide an appropriate context, a highly reliable scale was developed based on an established framework and a secondary scale was used for additional validation, the teaching approaches were alternated in the study such that participants had the opportunity to evaluate each approach twice, and qualitative data was used interpret the quantitative results.

However, there were a number of limitations in this study that provide opportunities for future research, including issues with the size and representativeness of the sample, issues relating to the researcher also being the instructor, survey fatigue and non-response bias, the constant pedagogical change, the limited qualitative data collected, the limited assessment of student performance, issues with differentiating the teaching approach by in-class learning activity, and issues matching learning activity to learning objective. Each of these will be discussed in turn.

5.7.2 Small, Non-Representative Sample

All of the students in this study were in the same program cluster, taking the same computer programming course, taught by the same instructor, at one community college. In particular, almost all the students in this study were male, which is obviously not representative of the entire community college student population. Given this relatively small convenience sample, generalizations cannot be made about the flipped classroom approach and its suitability for all community college students. Additional research is needed that involves more students with different instructors in a greater variety of programs and courses at different community colleges.

5.7.3 Researcher was the Instructor

In any study of student participants in which the researcher is also the instructor, potential issues arising from the unequal power relationship between the students and the instructor need to be addressed (Clark, & McCann, 2005; Comer, 2009). Students may believe that a decision to decline participation or respond candidly could have a negative impact on their relationship with the instructor or otherwise disadvantage them, which poses ethical problems (Comer, 2009, Clark, & McCann, 2005) and calls into question the validity of the data being collected.

To mitigate these issues, measures were taken in this study to ensure the anonymity of the participants (Clark, & McCann, 2005; Comer, 2009), such as the use of an on-line survey platform so students could take the survey in a private environment, outside of the classroom (Comer, 2009) and avoiding the collection of demographic information that could be used to triangulate certain participants' identities (Clark, & McCann, 2005; Comer,

2009). In addition, the students' right to decline to participate without fear of repercussions (Clark, & McCann, 2005) was explicitly communicated (Appendix B).

While there was no indication that these measures were not effective in this study, it may be prudent in future research to separate the instructor and researcher roles (Clark, & McCann, 2005; Comer, 2009).

5.7.4 Survey Fatigue and Non-Response Bias

The student response rate for surveys in this study decreased from nearly half the students at the beginning of the study, to approximately one-eighth of the students by the end of the study. With seven different surveys for students to complete over the course of the semester, it is likely they experienced survey fatigue (Porter, Whitcomb, & Weitzer, 2004). As a consequence, there were an unequal number of students that responded to surveys for each approach, increasing the probability of non-response bias (Berg, 2005) for the flipped classroom approach surveys in particular.

5.7.5 Constant Pedagogical Change

Research suggests that the flipped classroom approach requires a change in student study habits (Guerrero, et al., 2013; Mason, et al., 2013a) and that acceptance of the flipped classroom approach took time (Butt, 2014; Mason, et al., 2013a; Van Veen, 2013). In this study, the teaching approach changed every two weeks, which did not give students much opportunity to acclimatize. As a result, student ratings of the less familiar approaches in this study may have been different than if the approach was used consistently throughout the course.

5.7.6 Limited Qualitative Data

The open-ended comments collected from students on the Post-Unit surveys provided explanatory information that was useful for interpreting the students' quantitative ratings. However, student interviews or focus groups might have yielded more in-depth qualitative data that would have been valuable for better understanding the differences among the three teaching approaches in this study

5.7.7 Limited Assessment of Student Performance

In this study, comparing student performance among the lecture/assignment, active/collaborative, and flipped classroom approaches was limited to analysing grades from quizzes that assessed the basic comprehension of unit content. Higher levels of learning were assessed in the course, however grades for these assessments were calculated using different criteria from one approach to another. As a result, this study contributed no insight into how the flipped classroom approach might impact the students' performance in reference to more demanding cognitive processes, such as to *apply*, *analyse*, *evaluate* and *create* (Krathwohl, 2002). Further research would be valuable in order to better understand how flipped teaching influences student performance at higher levels of learning and which kinds of performance objectives might be best addressed by a flipped classroom approach.

A second issue related to the limited student performance data in this study was the reliance on the students' self- assessments of how each teaching approach impacted their learning. While there is evidence that how students rate their learning often correlates with objective measurements of their performance (Benton, Duchon, & Pallett, 2013), there

was insufficient performance data collected to test the validity of the students' self-reported ratings of learning in this study.

5.7.8 Differentiating Approach by In-Class Learning Activity

This study compared specific implementations of three teaching approaches. An effort was made to clearly differentiate each one in order to provide the students with definitive items to compare. However, any of the approaches could have been implemented using other learning activities in the classroom. For example, the in-class lectures in this study featured several interactive elements such as active questioning, short class-level discussions, and demonstrations, which were manageable with class sizes of less than 40 students. From another perspective, such interactive lectures might be categorized as active-learning whereas "lecture" could refer to a one-way didactic presentation to hundreds of students at once. In another example, step-by-step guided instruction was the in-class learning activity used most often in the active/collaborative units of this study. In the flipped classroom approach, students solved more substantial problems together in class with less direction from the instructor. Although both activities are considered active learning, they are substantially different in terms of how cognitively demanding they are and the level of competency they are intended to develop. Active learning describes a broad variety of potential in-class teaching strategies, any of which might be used in a flipped classroom or an active learning based approach, potentially to different effect. One would expect that major variations in the learning activities used in the classroom for each of the three approaches might yield different ratings and observations from the students.

Further research is needed to understand any impact of the flipped classroom approach might have beyond the effectiveness of specific in-class learning activities. For example, comparisons between flipped classroom approaches and an active/collaborative approaches in which the same in-class teaching strategies are used might reveal the relative value of pre-class content videos more definitively.

5.7.9 Matching Learning Activity to Learning Objective

Anecdotally, it became evident in teaching this course that certain content lent itself to specific learning activities. For example, one of the learning objectives in one of the units in this course related to *in-line functions* in C++. Students needed to understand conceptually how an in-line function was different than a regular function and what the consequences on using in-line functions were. Procedurally, they needed recognize the conditions in which in-line functions should be used and how to implement an in-line function. In this study, in-line functions fell into one of the active/collaborative approach units, however, a guided hands-on exercise was not ideal for this content. The procedural aspects were very simple and arguably did not warrant the in-class time needed to perform a hands-on exercise. On the other-hand, the conceptual aspects of in-line functions were not easily demonstrated by practical application and would be extraordinarily difficult to discover through exploration. In this case, experiencing in-line functions in C++ seemed far less effective for learning than a direct explanation would have been. There were a few times through the course in which the learning objective and the learning activity prescribed by the teaching approach felt mismatched.

Ertmer and Newby (2013) argue that a full consideration of both the learner and the task is critical in the selection of an appropriate instructional strategy. If that is the case

then perhaps future research should focus on determining which kinds of learning activities (e.g. listening to a lecture, participating in a discussion, watching a video, following hands-on instructions, solving a realistic problem, etc.) are best suited to different learning objectives for students with various aptitudes and levels of experience.

5.8 Conclusion

The flipped classroom approach showed great promise in the literature when compared to lecture-based approaches in a university setting. Overall, the literature indicated that the majority of students had positive attitudes towards the flipped classroom. Although some students took time to get used to the flipped classroom, and others disliked it for the amount of independent learning required, most students reported that flipped approach enhanced their learning, especially when it came to applying knowledge and skills. Many students reported that flipped learning was effective for discussion and collaboration and they liked the increased feedback and interaction with the instructor. Most students in the literature tended to be highly engaged in the flipped classroom environment. Two things were missing from the literature however: first, any examination of the flipped classroom in a community college environment, and second, direct comparisons of the flipped classroom to teaching approaches based on active/collaborative learning. This study sought to address those gaps.

Generally, the community college students in this study had more modest attitudes towards the flipped classroom approach than the students in the literature. They rated the flipped classroom approach significantly higher than the lecture/assignment approach in terms of the overall learning experience and social presence. Key strengths of the flipped classroom approach in this study and the literature are the opportunity for students to

work with one another in class, and the availability of the instructor for guidance and immediate feedback in the classroom. However, when it came to overall attitudes and preferences, cognitive presence, and teaching presence, student ratings of the flipped classroom approach were not significantly different than the lecture/assignment approach. In particular, students in this study found that solving problems in-class was too difficult and they did not report any increased engagement, contrary to the literature.

Moreover, students in this study rated the active/collaborative approach significantly higher than the lecture/assignment approach in almost every category. Like the flipped classroom approach, they appreciated the increased collaboration and instructor interaction, however, they found the instructor-led classroom exercises more engaging.

These results have practical implications for community college instructors seeking a pedagogical refresh. Rather than investing considerable time and resources to develop on-line videos and other pre-class learning materials, it may be advisable instead to focus on carefully selecting in-class instructional strategies and designing better learning activities. These learning activities must align well with the knowledge and skill level of the students as well as the nature of the content or task to be learned (Ertmer & Newby, 2013). After full consideration, an instructor may determine that flipping some teaching is appropriate for their course, however, no singular teaching approach is ideal in all situations, including the flipped classroom approach.

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Appendix A – Literature Review Article Summary

Authors, Year	Discipline[1]	Contrasting Approach	Pre-class Activity	Linking Activity	In-Class Activity	Lvl[2]	Size[3]	Qual[4]	Quant[5]	Att[6]	Beh[7]	Perf[8]
Amiri, Ahrari, Saffar, & Akre, 2013	Multiple	Lecture	Repository video	-	Application, Collaboration, Discuss/Peer	U	100	Yes	Yes	Pos	Pos	-
Amresh, Carberry, & Femiani, 2013	Eng/Tech	Lecture	Instructor video	-	Application	U	39	Yes	Yes	Neg	-	Pos[ns]
Arnold-Garza, 2014	Skills	None	Instructor video	Explicit, In-class quiz	Directed, Discuss/Peer	U	148	Yes	Yes	Pos	Pos	-
Azemi, 2013	Eng/Tech	None	Instructor video	Review	Application, Collaboration, Discuss/Peer	U	-	Yes	Yes	-	Pos	Pos[ns]
Bijlani, Chatterjee, & Anand, 2013	Eng/Tech	None	Multimedia, Repository video, Supplements	Online quiz, Posting	Directed, Application, Discuss/Peer	G	7	Yes	No	Pos	-	-
Bishop, & Verleger, 2013b	Math/Sci	Lecture	Instructor video	Assignment, In-class quiz	Application, Collaboration, Discuss/Peer	U	164	No	Yes	-	-	-
Boucher, Robertson, Wainner, & Sanders, 2013	LS/Med	Lecture	Instructor video, Readings	Explicit	Application, Collaboration, Discuss/Peer	G	38	Yes	Yes	Pos	-	Mix
Butt, 2014	Math/Sci	Lecture	Readings	Posting, Review	Directed, Discuss/Peer	U	62	Yes	Yes	Pos	Pos	-

Authors, Year	Discipline[1]	Contrasting Approach	Pre-class Activity	Linking Activity	In-Class Activity	Lvl[2]	Size[3]	Qual[4]	Quant[5]	Att[6]	Beh[7]	Perf[8]
Critz & Knight, 2013	LS/Med	None	Instructor video, Readings	Online quiz	Application, Collaboration, Discuss/Peer	G	20	Yes	Yes	Pos	Pos	-
Davies, Dean, & Ball, 2013	Skills	Lecture, Simulation	Instructor video, Readings	Assignment	Directed[opt]	U	190	Yes	Yes	Pos	-	Mix
Davis & Minifie, 2013	Bus/Mgt	None	Readings	Assignment, Explicit	Application, Discuss/Peer	U	-	Yes	Yes	Pos	-	Pos[ns]
Enfield, 2013	Art/Hum	None	Instructor video	In-class quiz	Directed	U	37	Yes	Yes	Pos	Pos	-
Ferreri & O'Connor, 2013	LS/Med	Lecture	Readings	Explicit	Application, Collaboration, Discuss/Peer	U	300	Yes	Yes	Mix	-	Pos
Findlay-Thompson & Mombourquette, 2014	Bus/Mgt	Lecture	Instructor video	Assignment	-	U	108	Yes	Yes	Mix	-	ND
Forsey, Low, & Glance, 2013	Art/Hum	None	Instructor video	In-class quiz	Collaboration, Directed, Discuss/Peer	U	74	Yes	Yes	Pos	Pos	Pos[ns]
Frydenberg, 2013	Skills	None	Instructor video	In-class quiz	Collaboration, Directed, Discuss/Peer	U	66	No	Yes	Pos	Pos	-
Gannod, Burge, & Helmick, 2008	Eng/Tech	None	Instructor video	Explicit	Directed, Discuss/Peer	U	24	Yes	Yes	Pos	Pos	-
Gaughan, 2014	Art/Hum	None	Instructor video, Readings, Supplements	Implicit	Directed, Collaboration, Discuss/Peer	U	36	Yes	Yes	Pos	Pos	-

Authors, Year	Discipline[1]	Contrasting Approach	Pre-class Activity	Linking Activity	In-Class Activity	Lvl[2]	Size[3]	Qual[4]	Quant[5]	Att[6]	Beh[7]	Perf[8]
Guerrero, Baumgartel, & Zobott, 2013	Math/Sci	Active	Instructor video	-	Application, Collaboration, Discuss/Peer	U	49	Yes	Yes	Pos	Pos	ND
Herold, Lynch, Ramnath, & Ramanathan, 2012	Eng/Tecg	None	Collaboration, Instructor video*, Multimedia*, Readings*, Supplements*	Online quiz	Application, Directed	U, G	106	Yes	Yes	Pos	Pos	-
Hoffman, 2014	Soc-Sci	None	Collaboration, Instructor video[opt], Readings, Supplements	-	Application, Directed, Discuss/Peer	G	17	Yes	Yes	Pos	Pos	-
Kellogg, 2009	Eng/Tech	None	Interactive, Readings	Online quiz	Application, Collaboration, Discuss/Peer	U	-	Yes	Yes	Pos	-	Pos[ns]
Kellogg, 2013	Eng/Tech	None	Interactive, Readings	Online quiz	Application, Collaboration, Discuss/Peer	U	-	Yes	Yes	Pos		Pos[ns]
Lage, Platt, & Treglia, 2000	Bus/Mgt	None	Instructor video*, Multimedia*, Readings*, Supplements*	Explicit	Application, Collaboration, Directed, Discuss/Peer	U	200	Yes	Yes	Pos	Pos	-

Authors, Year	Discipline[1]	Contrasting Approach	Pre-class Activity	Linking Activity	In-Class Activity	Lvl[2]	Size[3]	Qual[4]	Quant[5]	Att[6]	Beh[7]	Perf[8]
Larson & Yamamoto, 2013	Skills	Lecture	Readings, Repository video[opt]	-	Application	U	125	Yes	Yes	Pos	-	ND
Lasry, Dugdale, & Charles, 2014	Math/Sci	None	Readings, Repository video, Supplements	Explicit	Directed, Collaboration, Discuss/Peer, Reflection	U	-	No	No	Pos	Pos	-
Love, Hodge, Grandgenett, & Swift, 2014	Math/Sci	Lecture	Instructor video, Readings, Supplements	Online quiz	Application, Collaboration, Discuss/Peer	U	55	No	Yes	Pos	-	ND
Lucke, Keyssner, & Dunn, 2013	Eng/Tech	None	Interactive	Assignment, Explicit	Application, Collaboration, Discuss/Peer	U	35	Yes	Yes	Pos	Pos	ND[ns]
Mason, Shuman, & Cook, 2013a	Eng/Tech	Lecture	Instructor video	Online quiz	Application, Collaboration, Discuss/Peer	U	40	Yes	Yes	Pos	Pos	Pos
Mason, Shuman, & Cook, 2013b	Eng/Tech	Lecture	Instructor video	Online quiz	Application, Collaboration, Discuss/Peer	U	60	Yes	Yes	Pos	-	ND
McGivney-Burelle & Xue, 2013	Math/Sci	Lecture	Instructor video	In-class quiz	Application, Collaboration, Discuss/Peer	U	60	Yes	Yes	Pos	Pos	Pos[ns]
McLaughlin et al., 2013	LS/Med	Lecture	Instructor video	Implicit	Application, Collaboration, Directed, Discuss/Peer	U	19	Yes	Yes	Pos	Pos	ND

Authors, Year	Discipline[1]	Contrasting Approach	Pre-class Activity	Linking Activity	In-Class Activity	Lvl[2]	Size[3]	Qual[4]	Quant[5]	Att[6]	Beh[7]	Perf[8]
McLaughlin et al., 2014	LS/Med	Lecture	Instructor video	Implicit	Application, Collaboration, Directed, Discuss/Peer	U, G	150	Yes	Yes	Pos	Pos	Pos
Missildine, Fountain, Summers, & Gosselin, 2013	LS/Med	Lecture	Recorded lecture	-	Collaboration, Directed	U	589	No	Yes	Neg	-	Pos
Murphree, 2014	Art/Hum	None	Readings	Explicit	Application, Discuss/Peer	U	85	Yes	Yes	Pos	-	-
Pierce & Fox, 2012	LS/Hum	None	Recorded lecture	Implicit	Application, Collaboration, Discuss/Peer	U	71	No	Yes	Pos	Pos	Pos
Ryan, 2013	LS/Hum	None	Collaboration	Assignment, Implicit	Directed	U	-	Yes	Yes	Pos	Pos	-
Sadaghiani, 2012	Math/Sci	None	Interactive	-	Directed	U	138	Yes	Yes	Pos	Pos	Pos[ns]
Sales, 2013	Soc-Sci	None	Online video	Explicit	Directed, Discuss/Peer	U	-	Yes	No	Pos	Pos	-
Schwartz, 2014	Math/Sci	None	Instructor video	-	Collaboration, Directed, Discuss/Peer	G	9	Yes	Yes	Pos	-	ND[ns]
Slomanson, 2014	Soc-Sci	None	Instructor video	Assignment	Application, Collaboration, Directed, Discuss/Peer	G	139	Yes	Yes	Pos	Pos	-
Strayer, 2012	Math/Sci	Lecture	Interactive	Implicit	Application	U	50	Yes	Yes	Mix	Pos	-

Authors, Year	Discipline[1]	Contrasting Approach	Pre-class Activity	Linking Activity	In-Class Activity	Lvl[2]	Size[3]	Qual[4]	Quant[5]	Att[6]	Beh[7]	Perf[8]
Talley & Scherer, 2013	LS/Med	Lecture	Instructor video, Readings, Supplements	Practice quiz	Directed, Discuss/Peer	U	-	Yes	Yes	Pos	-	Pos
Taylor, McGrath-Champ, & Clarkeburn, 2012	Bus/Mgt	None	Readings, Supplements	Implicit	Application, Collaboration, Discuss/Peer, Reflection	U, G	461	Yes	Yes	Pos	-	-
Toto & Nguyen, 2009	Eng/Tech	None	Instructor video	In-class quiz	Application, Directed	U	74	No	Yes	Pos	-	-
Tune, Sturek, & Basile, 2013	LS/Med	Lecture	Instructor video, Readings, Supplements	In-class quiz	Application, Discuss/Peer	G	27	No	Yes	Mix	Pos	Pos
Van Veen, 2013	Eng/Tech	None	Instructor video, Readings	Implicit	Application	U, G	55	Yes	Yes	Pos	Pos	Pos
Wilson, 2013	Math/Sci	None	Readings, Repository video[opt]	Online quiz	Application, Reflection	U	50	Yes	Yes	Pos	Pos	Pos

Authors, Year	Discipline[1]	Contrasting Approach	Pre-class Activity	Linking Activity	In-Class Activity	Lvl[2]	Size[3]	Qual[4]	Quant[5]	Att[6]	Beh[7]	Perf[8]
Yeung & O'Malley, 2014	Math/Sci	None	Instructor video	-	Application, Directed	U, G	52	Yes	Yes	Pos	-	-

Notes:
[1] Academic discipline: Art/Hum – Arts/Humanities, Bus/Mgt – Business/Management, Eng/Tech – Engineering/Technology, Skills -Technical Skills, LS/Med - Life Science/Medicine, Math/Sci – Math/Science, Soc-Sci – Social Science.
[2] Academic level: U – Undergraduate, G – Graduate.
[3] Sample Size.
[4] Study utilized qualitative data sources such as open-ended survey questions or interviews.
[5] Study utilized quantitative data sources such as Likert-scale surveys or grade data.
[6] Impact on student attitudes: Pos – positive, Mix – mixed, Neg – negative, ND – no difference.
[7] Impact on student behaviours: Pos – positive, Mix – mixed, Neg – negative, ND – no difference.
[8] Impact on student performance: Pos – positive, Mix – mixed, Neg – negative, ND – no difference.
* Students choose between multiple alternative formats.
[opt] Student use optional.
[ns] Statistical significance not reported.

Appendix B – Letter of Information

Letter of Information

You are invited to participate in a research study being conducted by Thom MacDonald. This research is being conducted in partial fulfilment of a Master's Degree, under the supervision of Dr. Robin Kay of University of Ontario Institute of Technology (UOIT). The purpose of this study is to gain insight into using specific teaching approaches in a computer programming course at the college-level.

You will be asked to complete a 20-minute on-line survey. This is one of a series of surveys you will be asked to complete. Questions in this survey will focus on demographic information, computer and programming skill level, and your opinions about in-class and out-of-class learning. Completion of this and any other survey in this study is voluntary. There are no foreseeable risks to you to participate in this study, and you do not waive any rights to legal recourse in the event of research-related harm by participating. Note that there are no repercussions to you if you choose not to participate.

Any information you provide is confidential and anonymous. No potentially identifying information will be linked to your responses. At the outset of this course you were provided with a unique code. In order to preserve your anonymity, no record is kept that can link this code to your identity. You may choose to provide this unique code when completing this survey; however this option is your decision.

The only people that will have access to the data you provide are Thom MacDonald and Dr. Kay. Survey data from this study will be stored securely for five years after any paper authored by Thom and/or Dr. Kay resulting from this study is published, at which point the data will be deleted.

You are not obliged to answer any questions that you find objectionable or that make you feel uncomfortable. While completing the survey, you may withdraw your participation from this study at any time without consequence by clicking the "Discard responses and exit" button. Please note that it will not be possible to delete responses from an anonymous survey that you have already submitted.

Although there may be no immediate benefit to your participation in this study, your contributions may serve to inform instructors about better teaching approaches for future courses. The findings of this study may be reported in educational journals or presented at conferences, but any information shared will be aggregated so that individual participants cannot be identified. If you are interested in receiving a copy of the study findings, you can contact Thom.

This study has been reviewed and accepted by the Research Ethics Board at University of Ontario Institute of Technology (UOIT) (REB # 13-042).

Consent Decision

By selecting "I agree to participate" below, you confirm that you:

- are 18 years of age or older and have the legal authority to consent to participate;
- understand what is required based on reading the Letter of Information and had any questions answered to your satisfaction;
- understand your right to refuse to respond to material that you find objectionable or makes you uncomfortable;
- understand that your participation is voluntary and that you free to withdraw at any time without consequence by exiting the survey; and
- understand that your identity is confidential and your responses are anonymous.

☐ I agree to participate.
☐ I do not agree to participate.

Appendix C – Demographic/Culture of Learning Survey Questions

1. What is your age?

☐ Under 20
☐ 20 - 24
☐ 25 - 29
☐ 30 - 34
☐ 35 - 39
☐ 40 - 44
☐ 45 - 49
☐ 50 and over

2. Please indicate your program.

☐ Computer Programmer
☐ Computer Programmer Analyst
☐ Computer Systems Technician
☐ Computer Systems Technology

3. Please select your section number (CRN).

☐ 21153
☐ 23901
☐ 26528

4. Computing Comfort and Skills. Please select your level of agreement with the following statements:

(Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

a. I am comfortable using a computer.
b. I can use and manage e-mail and/or other forms of direct messaging (e.g. Skype™).
c.* I can organize and manage files, folders, and drives (e.g. create, locate, move, delete).
d.* I can create and edit documents using productivity software (i.e. word processing, spreadsheets, presentation software).
e. I can create and edit basic media files (i.e. images, sound recordings, online videos).
f.* I can usually find what I am looking for on the Internet.
g.* I can use the college learning management system.
h. I can use the college portal website (i.e. MyCampus).
i. I can use one or more social networking websites (e.g. LinkedIn™, Facebook™), including manage my profile, basic settings, etc.
j.* I can use a blog, wiki, and/or online discussion board to share and discuss content.
k.* I can usually troubleshoot and fix basic problems with my computer with minimal help.
l. I can install new software with minimal help.

Note:
* Computing skills required for the blended learning environment of the course.

5. Please rate your programming skill level.

☐ Beginner - I need help to write a simple program.
☐ Developing - I can write a program with some help, but I am just learning.
☐ Intermediate - I can write programs on my own but I could learn more.
☐ Advanced - I can write useful programs on my own and I help others learn.
☐ Expert - I write useful programs professionally and I frequently help others learn

6. Please rate your interest level in programming.

☐ Not at all interested
☐ Slightly interested
☐ Moderately interested
☐ Very interested
☐ Extremely interested

7. In-Class Learning Activities. Please select your level of agreement with the following:
(Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

a. Listening to the instructor explain course concepts in a lecture helps my learning.
b. Watching the instructor demonstrate course concepts with practical examples helps my learning.
c. Discussing course concepts as a class helps my learning.
d. Discussing course concepts in small groups in class helps my learning.
e. Working on hands-on problems on my own in class helps my learning.
f. Working on hands-on problems in small groups in class helps my learning.
g. Being guided by the instructor through hands-on problems as a class helps my learning.

8. Out-of-Class Learning Activities. Please select your level of agreement with the following:
(Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

a. Reviewing course materials (e.g. textbook, lecture notes) before class helps my learning.
b. Reviewing course materials (e.g. textbook, lecture notes) after class helps my learning.
c. Completing pre-class assignments (e.g. assigned readings and quizzes) helps my learning.
d. Working on hands-on homework problems on my own helps my learning.
e. Working on hands-on homework problems in small groups helps my learning.

9. Out-of-Class Time. Please select the range of hours-per-week that best matches your choice:
(Less than 1 hr/week, 1 - 2 hr/week, 2 - 4 hr/week, 4 - 6 hr/week, 6 - 8 hr/week, 8 - 10 hr/week, Over 10 hr/week)

a. How much work outside of class is typical for one college course?
b. What is the maximum amount of work outside of class you have spent for one college course?

Appendix D – Post-Unit Survey Questions

Teaching and Guidance

Please select your level of agreement with the following statements:
(Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

1. The instructor clearly communicated how the learning activities contributed to the goals for this unit.
2. L/A The instructor clearly communicated the student participation expectations for lectures/demonstrations.[1]
2. A/C The instructor provided clear instructions on how to participate in in-class guided/group activities.[1]
2. Flip The instructor provided clear instructions on how to complete pre-class video assignment(s)[1]
3. L/A The instructor provided clear instructions on how to complete individual homework problems.[2]
3. A/C I clearly understood what I needed to do outside of class to help me learn.[2]
3. Flip The instructor provided clear instructions on how to participate in in-class guided/group activities.[2]
4. The instructor was helpful in guiding the class towards understanding unit topics in a way that helped me clarify my thinking.
5. L/A Solving homework problems on my own[3] helped me to learn.
5. A/C Solving problems in-class in small groups[3] helped me to learn.
5. Flip Solving problems in-class in small groups[3] helped me to learn.
6. The instructor helped keep the course participants on task during this unit in a way that helped me to learn.
7. The instructor encouraged course participants to explore new concepts in this unit.
8. Instructor actions during this unit reinforced the development of a sense of community among course participants.
9. The instructor provided useful feedback during this unit.
10. The feedback provided during this unit was when I needed it.

Notes:

L/A Lecture/assignment approach question version.
A/C Active/collaborative approach question version.
Flip Flipped classroom approach question version.
[1] Refers to initial exposure to unit learning prescribed by the teaching approach.
[2] Refers to subsequent exposure to unit learning prescribed by the teaching approach.
[3] Refers to problem solving in the format prescribed by the teaching approach.

Group Interaction

Please select your level of agreement with the following statements:
(Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

11. My interaction with other course participants during this unit gave me a sense of belonging in the course.
12. [L/A] The lecture/demonstrations[1] for this unit provided an excellent medium for in-class interaction between course participants.
12. [A/C] The guided/group activities[1] for this unit provided an excellent medium for in-class interaction between course participants.
12. [Flip] The guided/group activities[1] for this unit provided an excellent medium for in-class interaction between course participants.
13. I felt comfortable participating in discussions in class for this unit.
14. I felt comfortable disagreeing with other course participants while still maintaining a sense of trust during this unit.
15. I felt that my point of view was acknowledged by other course participants during this unit.
16. In-class discussions during this unit helped me to develop a sense of teamwork.

Notes:
[L/A] Lecture/assignment approach question version.
[A/C] Active/collaborative approach question version.
[Flip] Flipped classroom approach question version.
[1] Refers to in-class learning activities prescribed by the teaching approach.

Thinking and Learning

Please select your level of agreement with the following statements:
(Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

17. The problems posed in this unit increased my interest in C++/programming.
18. I felt motivated to explore C++/programming related questions.
19. I utilized a variety of information sources to explore problems posed in this unit.
20. In-class discussions during this unit were valuable in helping me appreciate different perspectives.
21. L/A A pre-class video assignment(s) for this unit would not have made in-class discussions better.
21. A/C A pre-class video assignment(s) for this unit would not have made in-class discussions better.
21. Flip The pre-class video assignment(s) for this unit made in-class discussions better.
22. The learning activities for this unit helped me learn what I needed to know.
23. I have developed solutions to problems that I can apply in practice.

Notes:
L/A Lecture/assignment approach question version.
A/C Active/collaborative approach question version.
Flip Flipped classroom approach question version.

Difficulty Level

Please rate the difficulty level of each of the following:
(Far Too Easy, Too Easy, About Right, Too Hard, Far Too Hard)

24. L/A Rate the difficulty level of the content presented in the lecture/demonstrations [1]:
24. A/C Rate the difficulty level of the in-class guided/group activities[1]:
24. Flip Rate the difficulty level of the in-class guided/group activities[1]:
25. Rate the difficulty level of your work outside of class for this unit:

Notes:
L/A Lecture/assignment approach question version.
A/C Active/collaborative approach question version.
Flip Flipped classroom approach question version.
1 Refers to in-class learning activities prescribed by the teaching approach.

Time Investment

Please rate your level of time investment for each of the following:
(Far Too Little, Too Little, About Right, Too Much, Far Too Much)

26. L/A Rate the amount of time we spent in lecture/demonstrations[1] for this unit:
26. A/C Rate the amount of time we spend on in-class guided/group activities[1]:
26. Flip Rate the amount of time we spend on in-class guided/group activities[1]:
27. Rate the amount of time you spent on work outside of class for this unit:

Notes:
L/A Lecture/assignment approach question version.
A/C Active/collaborative approach question version.
Flip Flipped classroom approach question version.
1 Refers to in-class learning activities prescribed by the teaching approach.

Value and Preference

Please select your level of agreement with the following statements:
(Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

28. L/A	The lecture/demonstrations[1] for this unit were worthwhile.
28. A/C	The in-class guided/group activities[1] for this unit were worthwhile.
28. Flip	The in-class guided/group activities[1] for this unit were worthwhile.
29.	The work I did outside of class for this unit was worthwhile.
30. L/A	The teaching approach for this unit (i.e. lecture/assignment)[2] was a good way for me to meet my learning goals.
30. A/C	The teaching approach for this unit (i.e. in-class guided/group activities)[2] was a good way for me to meet my learning goals.
30. Flip	The teaching approach for this unit (i.e. pre-class video assignment(s) and in-class guided/group activities)[2] was a good way for me to meet my learning goals.
31. L/A	I would prefer most of my courses to follow this teaching approach (i.e. lecture/assignment)[2].
31. A/C	I would prefer most of my courses to follow this teaching approach (i.e. in-class guided/group activities)[2].
31. Flip	I would prefer most of my courses to follow this teaching approach (i.e. pre-class video assignment(s) and in-class guided/group activities)[2].

Notes:

L/A Lecture/assignment approach question version.
A/C Active/collaborative approach question version.
Flip Flipped classroom approach question version.
[1] Refers to in-class learning activities prescribed by the teaching approach.
[2] Refers to all learning activities prescribed by the teaching approach.

Benefits and Challenges

32. L/A What were the benefits of the lecture/assignment teaching approach[1] for you?
32. A/C What were the benefits of the active learning approach[1] for you?
32. Flip What were the benefits of the flipped teaching approach[1] for you?

33. L/A What were the challenges of the lecture/assignment teaching approach[1] for you?
33. A/C What were the challenges of the active learning approach[1] for you?
33. Flip What were the challenges of the flipped teaching approach[1] for you?

Notes:
L/A Lecture/assignment approach question version.
A/C Active/collaborative approach question version.
Flip Flipped classroom approach question version.
1 Refers to the teaching approach used in the unit.

Appendix E – Qualitative Data Theme Descriptions

Category:	Subcategory Theme	Description
Cognitive Presence:		
	Engagement	
	Promoting Interest	The impact on interest in computer programming.
	Sustaining Attention	The ability to pay sufficient attention.
	Knowing and Understanding Basic Concepts	
	Ability/Ease	The ability or level of difficulty to achieve basic concepts comprehension.
	Explained Examples	The impact of the instructor explaining example code in class.
	Learning by Doing	Hands-on activity and its value to achieve basic concepts comprehension.
	Pressure/Stress	The presence of pressure/stress.
	Review for Comprehension	The value of materials (activity products, videos, example code/slides) to review for basic concepts comprehension.
	Technical Content/Syntax	The ability to comprehend technical details like syntax and keywords.
	Theoretical Content	The ability to comprehend theoretical content.
	Time to Absorb Content	The suitability of pace of the content/activities.
	Integrating and Applying Learning	
	Ability/Ease	The ability or level of difficulty to apply concepts to a contextual problem (i.e. lab-project).
	Explore/Experiment	The opportunity to explore/experiment.
	In-Class Time Allocation	The suitability of the time allocated to lab-project work in class.
	Reference for Application	The value of materials (activity products, videos, example code/slides) as a reference to assist in application.

Category:	Subcategory Theme	Description
Teaching Presence:		
	Design/Organization	
	Assignment/Activity Instructions	The clarity of lab-project requirements and pre-class assignment instructions.
	Class Size	The suitability of the number of students in class.
	Content Segmenting	How learning content was broken-down and its impact.
	Grading/Incentive	How grades were assigned and its impact.
	Novelty	If the approach featured novel elements.
	Time/Place Flexibility	If and how the approach allowed time/place flexibility.
	Topic Coverage Efficiency	The amount of content covered in a fixed amount of time.
	Direct Instruction	
	Amount/Clarity	The amount and clarity of direct instruction.
	Detailed Explanation	The degree of detailed explanation afforded by direct instruction.
	Signaling Priority	The degree to which direct instruction signaled what content was important.
	Guidance/Feedback	
	Available When Needed	Whether guidance and feedback was available when students required it.
	Peer Support	Guidance and feedback from peers and its impact.
	Independent Learning	
	Self-Direction	The opportunity/need for students to direct their own learning and its impact.
	Workload	The amount of work required outside of class and its impact.

Category:	Subcategory Theme	Description
Social Presence:		
	Cohesion	
	Group Identity	The degree to which the students identify with the class-group.
	Keeping Pace in Class	Students keeping pace with one another in class and its impact.
	Collaboration	
	Class-Level Discussion	Class-level discussion and its impact.
	Interdependence	If and how an individual's learning was effected by the aptitude and behaviour of others.
	Small Group Work	Small group work and its impact.
General:		
	General Assessment	
	Affinity	Liking or disliking the approach as a whole.
	Learning/Self-Efficacy	Subjective assessment of the impact on learning in general.
	No Benefits/No Challenges	Lacking benefit (-) or lacking challenge (+). Only where explicitly stated; non-entry excluded.

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