

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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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.