

MULTIDIMENSIONAL TEACHING: THOUGHTFUL WAYS OF CREATING A FLIPPED CLASSROOM

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ABSTRACT. The “flipped” or “inverted” classroom, in which students study lecture-type material at home and do their “homework” in the classroom, has been the subject of research, particularly in the area of student achievement. Yet Bishop and Verleger (2013) state the need for an underlying theory to the practice. The purpose of this paper is to explore “multidimensional teaching,” the authors’ extension of the two-dimensional “flipped” classroom concept in light of Cambourne’s (1995) Conditions for Learning. One author’s math class for pre-service teachers was taught in two styles, a more traditional lecture format and in the “inverted” format. Students in the “flipped” format achieved at a higher level. Moreover, students’ open-ended comments reveal that Cambourne’s Conditions for Learning were implicit to the teaching practice. The authors suggest that practitioners of this style of teaching should deliberately develop student-centered practices, such as those mentioned by Cambourne, in order to retain the power that this teaching style currently has.

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1. Introduction

Some might call ‘a flipped classroom’ hype and others might call it innovation: the concept of the “flipped” or “inverted” classroom has become the subject of numerous research studies (see below) as well as contemplation in journals such as the *Chronicle of Higher Education* (Berrett, 2012). Claims for its positive effect on student achievement are largely positive (see below), with some important caveats. Yet, definitions of the concept vary as do the teaching practices associated with this amorphous concept.

For the “flipped” classroom as a teaching practice to live beyond its current “fifteen minutes of fame”, the theory behind the practice needs to be fleshed out in relation to the factors that make it effective and how to build upon that effectiveness. The purpose of this article is to move the discussion of “flipped” classrooms out of a simple two-dimensional metaphor and into a construct that better represents the complexity of the teaching-learning relationship, “multi-dimensional teaching”, which we do using Cambourne’s (1995) Conditions of Learning. Following that discussion, the authors present students’ reactions to such a practice at Capital University.

2. Flipped Classrooms in the Literature

Bishop and Verleger(2013) and Hamden et al.(2013) provide an extensive review of the literature related to the general concept of inverted or flipped classrooms. Our review of the literature considers the complexities of learning in the flipped classroom that lead us to our claim that this kind of teaching is multidimensional. For example, Talbert(2012) and Findlay-Thompson and Mombourquette(2014) define the concept as simply an inversion of the standard classroom, suggesting that the salient features of the concept lie mainly in the fact that what was “homework” such as doing problems and exercise, became classwork and traditional classwork (listening to lectures) has become homework. Calter(2013) suggests that it is one of many technological tools that can be used in the teaching of hybrid courses. Tucker(2012) focuses on the use of videos outside of the classroom as a main feature of the flipped classroom and suggests that it is not the videos themselves that make this type of teaching work but, rather, how tools such as videos get used in

the classroom. Finally, Bishop and Verleger(2013) provide a structural definition(interactive learning within the classroom and individualized computer-based learning outside of the classroom) and brings to the fore the need for a theory-based framework on which to base the activities of the classroom in order for them to succeed. It is based on ideas such as those of Bishop and Verleger(2013) that we have opted to exchange “multi-dimensional teaching” as an active process of teachers for the place-based, less active term, “flipped” or “inverted” classroom.

3. The Significance of Multi-Dimensional Teaching

Multidimensional teaching as a “new” development is taking place not just in the context of the technology that makes it more do-able, with easy ways to create videos and other informational media and to provide students with access to them; it is also taking place in the paradigm shift between the seventeenth-century style teaching and learning and the ways teaching and learning could take place given the interrelated technological and informational revolutions. While it seems impossible to find statistics on the prevalence of the lecture method of teaching in K-12 schools or universities, many teachers apparently still practice broadcasting information in the classroom that students receive and write down. When it was difficult in the seventeenth century for students to gain access to knowledge through books because of the expense of printing them, it made sense for teachers to read and then share what they knew via lecturing. The word “lecture” contains this function as it is derived from the Latin word “read”. The information and technological revolutions, however, have made it possible for students to instantly find something out on their smart phones even while the teacher is lecturing.

The sharing of information remains an important aspect of teaching and newer technology allows teachers to meet this need through technology that lets students engage with information in the way that works best for their neurological processing. Yet if teaching involved merely the act of sharing information in a certain sequence, then there would not be constant talk in the news media of educational crises. The concept of multidimensional teaching gets at the roots of the teaching-learning relationship. In particular, Brian Cambourne(1995) outlines the conditions

necessary for people to learn, based on his observations of the differences between school-based learning and non-school-based learning. He noticed that students who struggled in school were, nevertheless, showing evidence of having learned complex skills and information at home and in their communities. He began his observations with the hope of bringing the conditions of outside-of-school learning into the classroom. While Cambourne's interest was specifically literacy, these conditions can be applied to mathematics; he specifically mentions students who had learned probabilities in relation to playing cards. Cambourne's conditions are:

- Immersion - This condition refers to the state of being saturated by, enveloped in, flooded by, steeped in, or constantly bathed in that which is to be learned.
- Demonstration - This condition refers to the ability to observe (see, hear, witness, experience, feel, study, explore) actions and artifacts.
- Engagement - Engagement ... has overtones of attention; learning is unlikely if learners do not attend to demonstrations in which they are immersed.
- Expectations - Young learner-talkers receive very clear messages that not only are they expected to learn to talk, but also that they are capable of doing it.
- Responsibility - The significant others in young learners' environments communicate very strong expectations that the learning task will ultimately be completed successfully, while simultaneously providing deep immersion with meaningful demonstrations. But the learners themselves decide the nature of the engagement that will occur.
- Approximations - When learning to talk, learner-talkers are not expected to wait until they have language fully under control before they're allowed to use it.
- Employment - This condition refers to the opportunities for use and practice that are provided by children's caregivers.
- Response - This condition refers to the feedback or information that learner-talkers receive from the world as a consequence of using their developing language knowledge and skills. (185-186)

While they are not explicitly part of the practice of teaching in a flipped classroom, Cambourne's Conditions of Learning are definitely implicit to some of the best practices of this teaching strategy. The

following Table 1 connects Cambourne's(1995) Conditions of Learning to practices often used in flipped classrooms.

Conditions	Multidimensional Teaching Practices in Flipped Classrooms
Immersion	The use of technology to provide multiple paths for engaging with information (e.g., texts, videos, demonstrations, simulations, etc.). Interactions during the class sessions as students discuss with each other and the teacher the ideas they are working with. Both of these are mentioned in multiple sources.
Demonstration	The use of teacher-made or internet-derived videos (e.g., Khan Academy) Bishop (2013) and Khan (2012) mention this practice.
Engagement	“Classroom time is no longer spent taking in raw content, a largely passive process. Instead, while at school, students do practice problems, discuss issues, or work on specific projects. The classroom becomes an interactive environment that engages students more directly in their education” Horn (2013) p. 78
Expectations	“Traditional classroom interactions are also flipped. Typically, the most outgoing and engaged students ask questions, while struggling students may act out. Bergmann notes that he now spends more time with struggling students, who no longer give up on homework, but work through challenging problems in class.” Tucker (2012) p. 82
Responsibility	“I stress this because I believe that personal responsibility [emphasis original] is not only undervalued but actually discouraged by the standard classroom model, with its enforced passivity and rigid boundaries of curriculum and time. Denied the opportunity to make even the most basic decisions about how and what they will learn, students stop short of full commitment.” Khan (2012)
Approximations	[More implicitly, as in the ways teachers move students from struggling to mastery] “In the flipped classroom, the teacher is available to guide students as they apply what they have learned online. One of the drawbacks of traditional homework is that students don’t receive meaningful feedback on their work while they are doing it; they may have no opportunity to relearn concepts they struggled to master. With a teacher present to answer questions and watch over how students are doing, the feedback cycle has greater potential to bolster student learning.” Horn (2013) p. 78
Employment	“ ‘In your presence they’re learning how to think, and we’re learning what they’re struggling with.’... It’s easy to measure [in a traditional classroom] if they can take derivatives out the wazoo,’ Ms. Rhea says, ‘but it’s kind of harder to see what they’re getting underneath.’ ” Barrett (2012)
Response	“Increased interactions between students and faculty: Entire class periods are dedicated to conversations between the students as they complete the in-class activities. Using this strategy shifts the focus from the front of the room. It moves the faculty member from the stage to interacting one-on-one with the students.” Bergmann, Overmeyer and Willie (2011), mentioned in Stone (2012) p. 1

TABLE 1. Multidimensional Teaching Practices in Flipped Classrooms

4. Research Method and Results

The present study explores multi-dimensional teaching in the context of the flipped classroom, as we conceptualized it when we began the data collection process. We present achievement data that demonstrates that students in this study achieved at a greater level than other students in a classroom taught by the same professor but with a more traditional means of teaching, based on four examinations normally given in the course. Student perspectives are explored through a Likert-scale survey and open-ended questions. Finally, we connect these data with the Cambourne's(1995) Conditions of Learning.

4.1. Data Collection. The study took place at a four-year private university located in central Ohio. There were 74 students participating in the study, from Math 140, Integrated Mathematics I, Spring 2013 (21 students), Fall 2013 (26 students) and Spring 2014 (27 students) semester. The Spring 2013 course was taught traditionally with lectures, homework problems, and examinations. The other two semesters were taught with a flipped class strategy:

Semester	Teaching Style	Number of Students
Spring 2013 (Jan ~ May, 2013)	Traditional (lecture-centered)	21
Fall 2013 (Sep ~ Dec, 2013)	Flipped Classroom	26
Spring 2014 (Jan ~ May, 2014)	Flipped Classroom	27

TABLE 2. Traditional and Flipped Classroom

Students were not randomly assigned to any of the groups; these are not data from an experimental research approach.

Math 140 is a critical course for students who are preservice teachers in the Early Childhood Education, K-5 program. It provides students with a prerequisite to formally enter the Education Program and it forms the basis for their succeeding math pedagogy classes. Students in Fall 2013 had no prior knowledge that the course they were enrolled in would be a flipped class. Students in Spring 2014 were not directly told that they would be in a flipped class, although it is likely that they were told informally by students who had been in the class during Fall 2013.

This study implemented a mixed-methods approach for data analysis. For the purpose of this research, Creswell and Plano Clark's (2006) definition was used:

Mixed methods research is a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches in many phases in the research process. As a method, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone. (p. 18)

This method allows for a broad analysis of the data while also ensuring that each participant was heard and understood in his or her own words. Data presented here consist of examination achievement, a Likert scale-based survey, and five open-ended questions.

4.2. Examination Data. The examination data from the flipped courses were compared with examination data from the same course taught in a more traditional (lecture) manner by the same professor during Spring 2013. The following table 3 presents the distribution of test scores across the traditional and flipped classrooms as well as a statistical analysis of each test.

Test scores, when graphed across all twelve exams (1 traditional and 2 flipped classrooms for each of the four tests), demonstrate a general improvement in scores in the flipped classrooms: Figure 1

Along with a higher mean for test scores, the distribution of scores demonstrates that more students were passing the tests, indicating that they were learning the test material more thoroughly: Figure 2

4.3. Survey Data. At the end of semester, one week prior to their final exam, students were given a survey with a Likert scale. Students had spent over four months with the flipped class and in this time had opportunities to develop their own likes, dislikes, and other perceptions about multidimensional class instruction. The survey focused on four major themes including self-learning, time, assignments, and general flipped classroom questions and included 15 five-level Likert Scale items. Cronbach alpha test for the survey is 0.825. Reversed questions reflect

	Test1			Test2			Test3			Final		
	Trad Sp 13	Flip Fa 13	Flip Sp 14	Trad Sp 13	Flip Fa 13	Flip Sp 14	Trad Sp 13	Flip Fa 13	Flip Sp 14	Trad Sp 13	Flip Fa 13	Flip Sp 14
Mean	68.89	75.13	79.33	65.43	79.81	80.16	73.19	79.05	83.79	76.32	80.98	85.19
Median	67.00	75.50	81.00	64.00	83.00	87.50	72.30	83.00	85.60	76.63	86.00	82.00
SD	17.74	16.04	16.52	18.08	18.45	17.77	9.43	16.04	10.41	15.13	13.88	10.19
Score Distribution												
100-90	5	5	7	3	10	11	1	9	8	3	9	10
89-80	1	4	8	2	4	4	5	4	9	5	9	11
79-70	3	9	8	4	2	4	6	7	8	6	3	5
69-60	8	3	2	3	6	2	8	2	1	3	3	0
59-50	3	3	1	4	4	3	1	2	1	3	1	1
49-	1	2	1	5	0	3	0	2	0	1	1	0
Total	5	5	7	3	10	11	1	9	8	3	9	10
Passing > 70%	42.90 %	69.20 %	85.19 %	42.80 %	61.50 %	70.37 %	57.10 %	76.90 %	92.59 %	67.00 %	80.80 %	96.30 %
	Chap 2-3			Chap 4-5			Chap 6-7			Final		

TABLE 3. Test Score Comparison

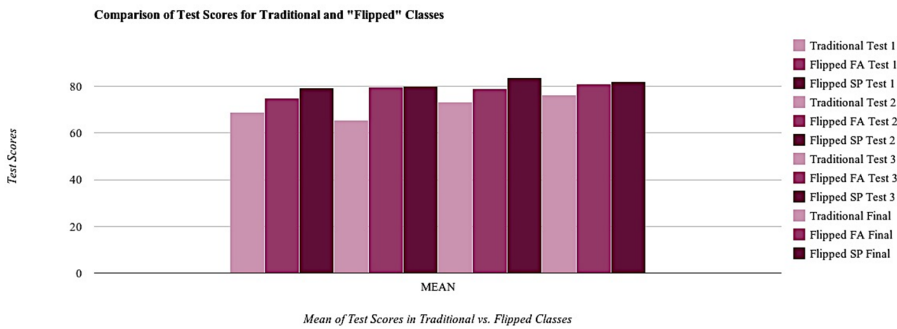


FIGURE 1. Achievement Graph 1

questions in which the positive response would be Strongly Disagree instead of Strongly Agree (Table 4).

A temptation in survey data using a Likert scale is to number students' responses (e.g., Strongly Agree = 5, Agree = 4, etc.) and then treat the result as cardinal numbers:

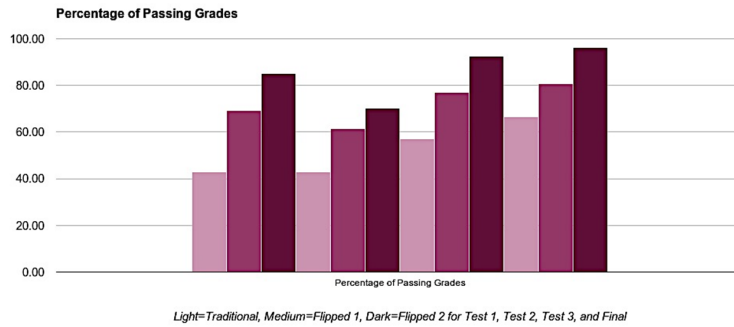


FIGURE 2. Achievement Graph 2

Q #	Type	Question
1	General Flipped	The Flipped classroom is more engaging than lecture based instruction.
2	General Flipped Reversed (question stated in the negative)	I would not recommend the Flipped Classroom to a friend.
3	General Flipped	The Flipped Classroom gives me greater opportunities to communicate with other students and teacher.
4	Assignments	I like reading assignment on textbook with handout.
5	Self-Learning, Reversed	I would rather have the entire class moving at the same pace in the course.
6	Time	I am spending less time working on traditional math homework like section exercise problems.
8	Assignments	I regularly read the textbook assignment.
8	Assignments, Reversed	I would rather watch a traditional teacher led lesson than a lesson reading with handout.
9	Self-Learning	I feel that mastery learning has improved my math understanding.
10	Self-Learning, Reversed	I dislike self-learning through the course.
11	Self-Learning	I find it easy to pace myself successfully through the course.
12	Time, Reversed	The Flipped Classroom gives me less class time to practice math.
13	General Flipped	I am more motivated to learn math in the Flipped Classroom.
14	General Flipped, Reversed	The Flipped Classroom has not improved my learning of mathematics.
15	Assignments	I would rather watch the lessons on video than reading the textbook with handout.

TABLE 4. The Survey

An underlying reason for analyzing ordinal data as interval data might be the contention that parametric statistical tests are more powerful than nonparametric alternatives. Also, conclusions and interpretations of parametric tests might be considered easier to interpret and provide more information than nonparametric alternatives (Allen & Seaman, 2007, para. 5).

Likert data are ordinal, rather than cardinal, which means that statistical analyses such as mean, median, standard deviation, etc., are invalid. The data in this study was treated as ordinal data because it was not possible for the participants to know the distance between any two choices on the survey.

For this reason, the results of the survey are reported in terms of numbers of students for each response, rather than the usual statistical analysis. We present several graphs detailing the responses in order to fully explore the survey data. Forty-two students responded to the statements on the survey. The following tables reveal their responses to the survey: Figure 3

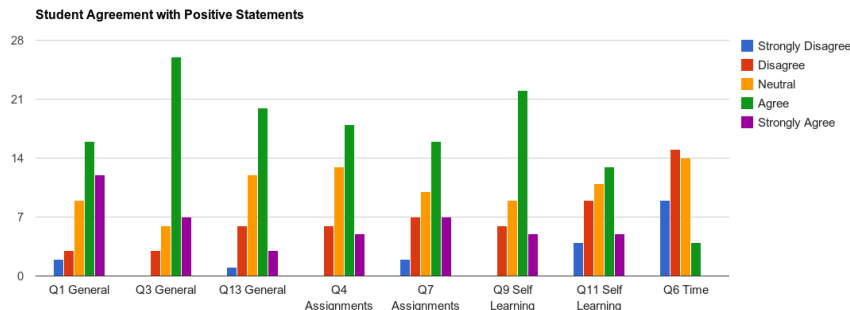


FIGURE 3. Student Agreement with Positive Statements

Students also responded to a set of statements that were worded negatively: Figure 4

When the reversed statement data are transposed so that Strongly Disagree becomes Strongly Agree (aligning the meaning of the statements), the responses to individual questions look like this: Figure 5

Next, we present a chart with the themes aggregated: Figure 6

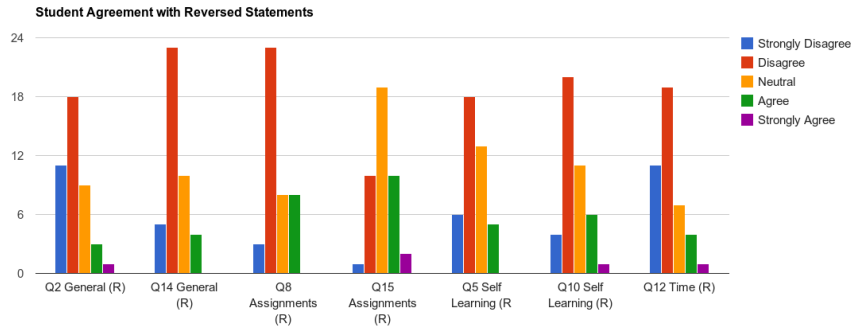


FIGURE 4. Student Agreement with Reversed Statements

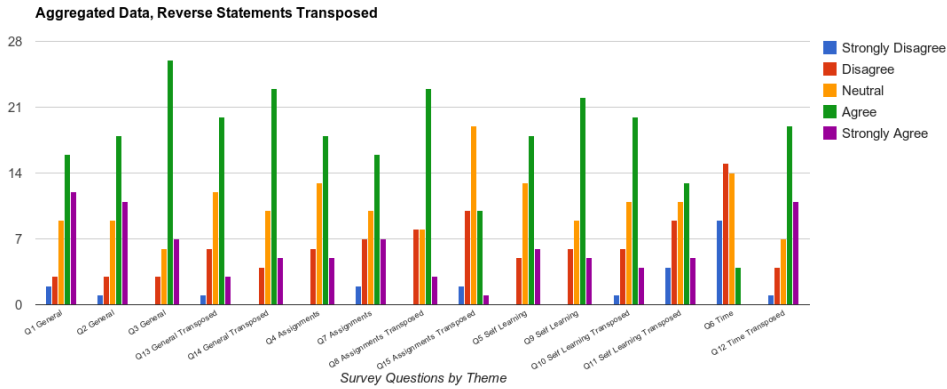


FIGURE 5. Aggregated Data, Reverse Statement Transposed

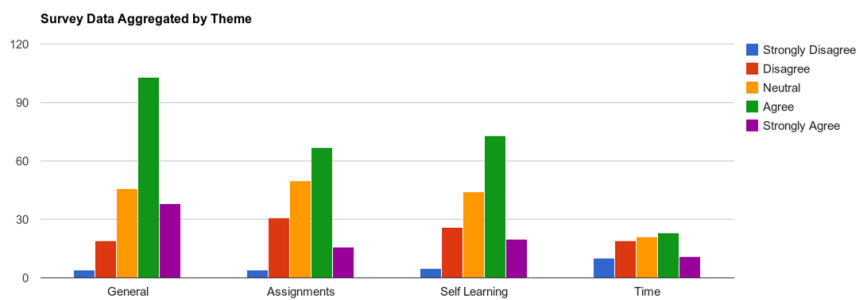


FIGURE 6. Survey Data Aggregated by Theme

Finally, we present a chart in which “Strongly Disagree” and “Disagree” are aggregated, as well as “Agree” and “Strongly Agree” : Figure 7

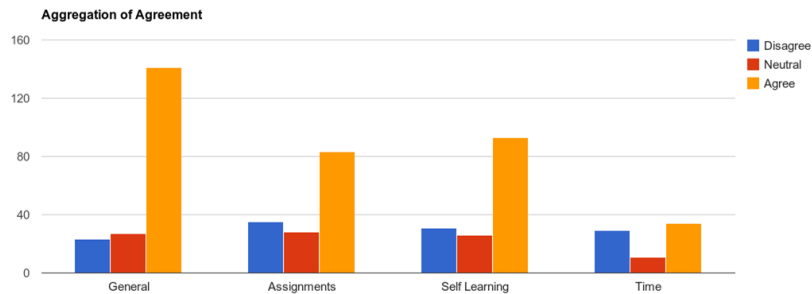


FIGURE 7. Aggregation of Agreement

The purpose of presenting this array of figures is to demonstrate exactly how survey data were analyzed and to keep the aggregation of data from hiding responses that bear consideration, such as those that indicate areas where students struggled or disliked aspects of the course. The charts move from more specific data to more aggregated data. The specific data reveal details while the aggregated data charts reveal more general trends.

Based on Figures 6 and 7 (Figure 7 makes the trends in Figure 6 easier to spot), it is clear that particularly in terms of the general idea of a flipped classroom as well as the idea of self-learning, students responded positively to the different strategy. The assignments category was much more even in response and time-related statements tended to be less positive in nature.

Figure 5 reverses the reversed questions so that the questions can be more easily compared. That is, the responses to the negative statements were transposed so that the responses aligned with the positive statements. Strongly Agree became Strongly Disagree, and so forth; only “Neutral” remained the same. This chart reveals that there is a strong agreement about the positive aspects of the course, with the exception of Q15. Question 15 asks whether students would prefer learning from a video or the textbook and the responses were largely neutral.

Figures 3 and 4 reveal the responses to different questions, by question structure. Questions structured in a positive way are reflected in Figure 3, while questions in which the meaning is reversed are reflected in Figure 4. An example of a positive statement would be: “The Flipped classroom is more engaging than lecture based instruction”, while a negative statement would be: “I would not recommend the Flipped Classroom to a friend”. The statements are not aligned, in that the reverse statements

are not restatements of the positive statements. Thus, these statements allow researchers to determine if students are reading the questions instead of just marking one number consistently across the survey just to finish with it quickly or because they are not invested in sharing their perspectives with the professor. However, while statements have general themes to them (General, Assignments, Self-Learning, and Time), a negative General statement cannot be expected to have an exact opposite array of answers as a corresponding positive statement.

Thus, question 14 is of interest, since it is a reversed statement and 18 students either Agreed or Strongly Agreed with it: “The Flipped Classroom has not improved my learning of mathematics”. The results for this question are masked by the aggregation of data, which means its strength of response is not sufficient to influence the survey data as a whole. A number of possibilities could lead to the results for this question. One is that the students did not fully read the question. The only word that turns this question into a “reversed” one is the 3-letter word, “not”. A second possibility is that students did not perceive of the flipped classroom as helping them in their achievement, since they had never experienced the curriculum of a math education course before and could only compare their experience in this class with their experiences of taking high school and college math courses. While a standard college math course and this math education course both have the topic of mathematics, the education course also includes the idea of pedagogy and of being able to reach answers to math questions in multiple ways. The research presented here compares test score data across three different classes and shows an improvement in achievement, but no individual student took both the traditional and the flipped version of the class, so they had less information with which to compare their performance.

4.4. Qualitative Analysis. In addition to survey data it was also important that the study include an understanding of the students’ perceptions of the flipped classroom in their own words. Five open-ended questions were asked of the students: the advantages of the flipped classroom, disadvantages, other, suggestions for improving the course, subjects in which flipped classrooms might work and a space for other comments.

Initially, we looked at advantages, disadvantages, and suggestions, since these questions pertained to students’ immediate experiences in the flipped classroom. Each student response was divided into meaningful phrases; where students expressed multiple ideas in a single sentence,

and coded into common themes that emerged through the open-ended questions. Across these three questions, students made 151 comments:

	Advantages	Disadvantages	Suggestions	
Book	1			
Comprehension	3			
Emotion	3	1		
Focus		2		
Learning Preferences		6	5	
Motivation	2	6		
Multiple Means	1			
Peers	18	2		
Procedures	8	3	16	
Resources		7	6	
Self expression	1			
Self teaching	23	3		
Struggles		9		
Teacher	5			
Time	10	4	4	
				Total Comments:
Totals	75	45	31	151

TABLE 5. Student Responses

Students made 18 comments suggesting that learning from peers was strength of the course; two comments focused on the negative side of this (issues such as difficulty understanding explanations by peers). We know from Vygotsky's work that peer learning can be very powerful. Developmentally, the majority of the students are still adolescent and both need and appreciate peer interactions in their learning experiences.

Students also commented about the need for self-teaching, and their comments were often connected to the comments about motivation. The vast majority of the comments mentioned self-teaching, as an advantage to the course structure, though some noted that self-teaching requires a high level of motivation that they struggled with. One of the challenges of moving from high school to college lies in students developing the motivation they need in order to become more independent learners.

Students made comments around the resources they felt were needed, course procedures, and how the course addressed or failed to address learning preferences, in their opinions. Suggestions for the course centered around these three issues and focused on expanding options for students, whether the desire for a little more whole class instruction or an increased number of practice problems.

Finally, time was mentioned both as an advantage and a disadvantage. Students liked being able to move at their own pace, although they sometimes felt that time in the classroom wasn't being used to best advantage.

The comments of the students reveal that they were thinking both as students themselves and as future teachers. This perspective was supported by the question about how the procedure might work for other courses although these comments also arose in response to other questions. Several comments revealed that students were considering how the procedure would work beyond the college classroom:

- I think the Flipped Classroom would be great for elementary students!
- Doesn't appeal to everyone. Not all students and schools have access to technologies that can work for this method. Students would be spending all of their homework time in front of a computer screen.
- Yes, I believe this method could be effective in most classrooms. Get students more involved and also, it will not be boring for them.
- Yes, [the flipped class strategy could work in other classrooms] I just think as a teacher you really need to be able to read your students to see if this style of teaching works specifically for them.

Because these students are in a teacher education program, they are learning the language of education and they use it in their analysis of their experiences with the flipped classroom. Their unique positions as both students and pre-service teachers provide insight into the characteristics of the flipped classroom that are truly multi-dimensional in nature.

4.5. Open-ended Questions in Relation to Cambourne's Conditions for Learning. The students, across the open ended questions about the course specifically and the idea of flipping classrooms in general, mentioned factors that connect with Cambourne's Conditions for

Learning. Comments were reviewed and coded in relation to the characteristics of each of the conditions. Not every comment received a code.

Immersion	Demonstration	Engagement	Expectations	Responsibility	Approximation	Employment	Response
7	11	11	1	26	7	16	34

TABLE 6. Cambourne’s Conditions for Learning Coding

Two conditions stood out: response and responsibility. Cambourne (1995) states that “response” is essentially feedback. He points out how critical immediate feedback is for children learning to speak their first language. The same appears to be true in the mathematics classroom: students generally appreciated that they could get quick feedback on their questions as well as their homework within the class through discussion with each other and asking questions of the professor. In the traditional lecture format of a mathematics class, teachers collect homework, grade it, and give it back the following session, perhaps days after the homework was turned in. Further, the feedback on the homework may not advance a student’s understanding of the problem. It appears that in Dr. Cho’s flipped classroom that the students received both immediate and helpful feedback.

Responsibility, the learner’s choice to learn, was mentioned both positively and negatively. Positive remarks included:

- It is student based and the student will get out what they put in.
- The advantages of the flipped classroom are that students have more control, it promotes student centered learning and collaboration, and it can be more efficient.
- I think that learning the material for myself is a good skill to learn.

At the same time, students recognized that being in a flipped classroom required intrinsic motivation and some struggled with that:

- [A disadvantage is] finding the motivation to look over the material thoroughly.
- The flipped classroom method relies on self-motivation and may be struggle for some students.
- Not motivated sometimes. Sometimes don’t want to read.

When we consider that one goal of education is to help students become lifelong learners, the message from this set of responses is that we need

to scaffold students' abilities to handle the responsibility of learning on their own.

Other responses students made indicated an appreciation for the condition of learning that was present or a desire for more of those conditions. For example, some students wanted more demonstrations and at least one student mentioned appreciation for links to videos that were part of the work done at home; the desire for more demonstrations can be fulfilled in many ways—mini lessons in class or videos that can be reviewed at home.

There was only one statement that could be coded as having something to do with expectation:

- The disadvantage is that it [flipped classroom] relies on preparation and trust.

Teachers must trust that students will learn and the flipped classroom is based on that foundational idea. If students do not attend the class session having done their part outside of class, the ability to use class time as a refinement of learning rather than the sole source of learning is compromised. Cambourne(1995) defines expectation as the message that learners get that they are capable of learning the material and that they are expected to do so. Being able to set up this kind of expectation in the classroom depends on the teacher's perspective about students: if a class is designed to reduce the number of students in an educational program through failing a certain amount of them in an introductory class, the expectation there is that some students will not learn. In contrast, looking at the improvement in exam scores and in the number of students passing exams across the two instances of flipped classrooms (above), it is clear that the goal here is that all students learn the math being taught. We would argue that this goal is essential to the healthy working of the flipped classroom.

4.6. Semiotics and the Multidimensional Classroom. Nine students made remarks in the open-ended questions that relate to the media through which the material was presented. It is interesting that some students felt that the class did not have enough visual content while others felt that it did not have enough aural content! In addition to these remarks, some students felt the speed of the class was too fast while others thought it was too slow. The point is that students are aware of the media through which they learn, which may be an artifact of using

teacher-education students in this research. Yet they raise an important consideration.

Along with the thoughtful use of Cambourne’s Conditions of Learning, attention to semiotic issues, such as the media used both in- and outside the classroom, can enhance the multi-dimensional aspect of the flipped classroom. Not only do students need multiple forms of media for each concept that engage their various senses (visual, auditory, touch), but they also need media that vary across the time required to derive meaning from the media. For example, an image can be read instantly while a video takes time to watch. Some students would benefit from a diagram that explains a concept while others would need a video that takes apart the concept more carefully.

5. Maintaining Multidimensional Classrooms

There is no such thing as a foolproof teaching method; the most creative forms of teaching can be subverted into teaching practices that alienate students and actively prevent learning. Conceptualizing the flipped classroom as simply an inversion of traditional teaching methods, with “lecture” taking place outside of the classroom and some kind of problem practice taking place inside the classroom fails to take into account the content of teaching philosophy and critical practices that support learning and the positive achievement results that have been reported.

Bishop and Verleger(2013, Figure 1: Flipped Classroom) created a visual conceptualization of the flipped classroom, as they describe it:

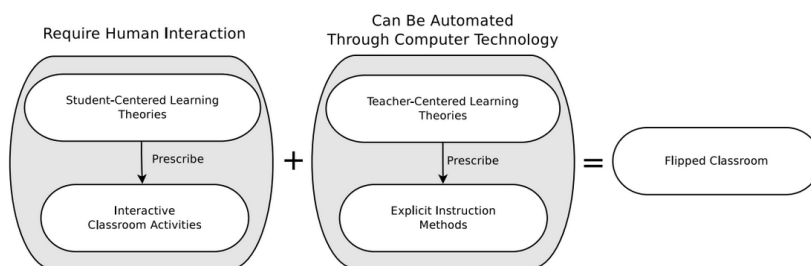


Figure 1: Flipped Classroom.

FIGURE 8. Bishop and Verleger’s Flipped Classroom

Their model demonstrates differences between in-class activities and computer-related activities and identifies the centrality of student-centered learning to the concept of flipping and it does so by identifying these practices as being connected to theory; they cite Piaget and Vygotsky in their discussion of this factor. Having a student-centered theory and implementing it in the classroom goes a long way towards preventing the flipped classroom from being just another trend in education that gets abandoned because the promising achievement results we see right now disappear. Student-centered theories require teachers to consider student perspectives (else the result would continue to be a teacher-centered classroom) and to invite these perspectives into the classroom as a major and valued teaching tool.

To this concept, we would add Cambourne's Conditions of Learning. As Cambourne(1995) points out, these conditions are very much present in successful learning that takes place outside of the school classroom, whether a baby is learning to talk or a person is independently learning a musical instrument; these conditions are central to and supportive of the learning process. Since students' adult learning will largely take place outside the classroom, these conditions are probably also critical for the development of lifelong learners. Cambourne's Conditions are also present in Hoyun Cho's flipped mathematics classroom, even though students were not directly asked about them. In fact, students' responses indicated a recognition of some of them as positive features of the classroom (e.g., appreciation of opportunities for immediate feedback). When they had less positive feelings about a condition, such as the need for students to take responsibility for their own learning, the conclusion we draw from this is that responsibility is critical for lifelong skills and attitudes students need to develop and we accept the challenge to scaffold in our students the ability to take responsibility and the intrinsic motivation that underlies it.

It is clear, not only from the review of the literature, but also from the results presented here, that flipped classrooms presently support higher levels of achievement among students. Survey data presented here indicate that students in general liked their experiences in Dr. Cho's flipped classrooms and the open-ended questions support that conclusion. In addition to this finding, which is so congruent with the findings of other researchers, we have further examined our data to see what else we can learn about how flipped classrooms can be so effective. In

applying Cambourne's Conditions for Learning to the concept of the inverted classroom, we conclude that the flipped classroom strategy is far more complex than simply turning a practice on its head. For this reason, we are using the concept of multi-dimensional learning to reflect a teaching strategy that is responsive to student learning needs and that takes advantage of the various media and technologies that are currently available to support teaching and learning.

As the flipped classroom strategy becomes popular with administrators at the university level because its use of work outside the classroom supports the current US Federal Government's time-based definition of a credit hour (a credit hour equals one hour in a classroom and three hours outside of the classroom) (Ochoa, 2011), at US K-12 educational levels because it can probably be made to support achievement on standardized tests, and in other contexts where achievement and accountability are measured by in ways that may have nothing to do with the actual quality of the classroom community, professors and teachers may be pressured into using this strategy. This means that while the form of the flipped classroom may continue to exist, its essence could be easily lost in our world of "bulimic" education (Firestein, 2013) where the educational philosophy is based on the idea of students ingesting a set of facts and then regurgitating them on tests.

We need more research that looks at student-centeredness and Cambourne's Conditions of Learning to see how significant these features are to student learning. We also need to develop ways of bringing colleagues on board to this type of teaching so that students can continue to benefit from it. This would include scaffolding the development of appropriate classroom activities, assisting with the choice of independent learning materials, along with a healthy dose of student- and learning-centered educational philosophies. Let us keep in mind that the true power in multi-dimensional teaching is the extent to which it addresses the actual learning needs of each student.

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