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Feedback in the Flipped High School STEM Classroom

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FEEDBACK IN THE FLIPPED HIGH SCHOOL STEM CLASSROOM

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ABSTRACT

This study examined how much feedback students received in the flipped high school science, technology, engineering and math (STEM) classroom. The flipped classroom is a pedagogical technique where students watch video instruction at home and complete collaborative activities in class. This technique has gained popularity in recent years, especially in STEM classrooms. The literature on the flipped classroom is inconclusive, with studies mainly conducted in higher education. Student and instructor perceptions were often studied, and those perceptions are generally positive about the flipped classroom, though there are concerns to consider. Student performance shows that the flipped classroom is at least not detrimental and may increase performance. Many studies mention that the flipped classroom increases interactions in the classroom, but most studies have not measured these interactions. This instructional model seems like a worthwhile approach to continue studying, especially in the high school classroom where less research has been conducted.

This study counted and timed feedback interactions in the flipped and traditional classroom. Student and teacher perceptions were also studied, with a focus on perceptions about feedback. While the quantitative results were inconclusive, the flipped classroom has potential to increase student-student feedback, but teacher-student feedback seems to have more to do with the tasks and/or method of instruction in class.

Students seemed to prefer the teacher-student interactions in the traditional classroom, but recognized that student-student interactions were improved in the flipped classroom. Future study is needed to determine what types of tasks and instruction affect feedback in the classroom.

DEDICATION

This work is dedicated to my parents, Mike and Rhonda Gilbreath, who supported me

throughout this endeavor. I would not have been able to finish without their love and

encouragement. I also dedicate this work to my grandparents, who left this world before

they could see me graduate but will always watch over me.

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CHAPTER 1: INTRODUCTION

The term feedback has its origins in engineering. A mechanical system self-regulates using feedback (Hattie & Yates, 2014). Feedback in engineering is when a machine takes part of the output and returns it to the input to improve the function of the machine by allowing self-correction. The history of using feedback to control a mechanical system is often thought to start with James Watt's steam engines. Watt used a device called a governor to regulate the speed in his machines, creating a control system using feedback (Hackl, 2017).

In education, feedback is used to help regulate learning. "Feedback should help the student understand more about the learning goal, more about their own achievement status in relation to that goal, and more about ways to bridge the gap between their current status and the desired status" (Sadler, 2010, p. 536). Feedback is an important element in the classroom. According to *Visible Learning for Mathematics: What Works Best to Optimize Student Learning*, which uses effect size to measure pedagogical techniques, an effect size of 0.40 represents one year of educational growth, and anything with an effect size above 0.40 is considered an effective educational strategy because it grows students beyond one year. Feedback has an effect size of 0.75, nearly double the standard. In fact, feedback is one of the top influences on educational growth (Hattie et al., 2017).

Not all feedback is effective. Group feedback is often not effective since "group-level feedback is largely irrelevant to those that have mastered an objective, and is ignored by those that have not" (Hattie & Yates, 2014, p. 46). Students need individualized feedback that is delivered as soon as their work is completed to their own liking (Hattie & Yates, 2014). This indicates a need for a two-fold change in the structure of the traditional, lecture-based classroom. First, to give more individualized feedback, more one-on-one attention from the teacher is required. Traditional instruction may not leave much one-on-one time between teacher and student. Second, students need to complete practice and tasks in the teacher's presence so that feedback can be delivered as soon as the work is complete. In the traditional model, most practice is done outside of the classroom as homework, so teachers are not there to guide students and deliver timely and useful feedback. One pedagogical technique that seems to solve these two problems is the flipped classroom, which moves lecture to homework and practice to class. This technique has gained popularity in recent years (Bishop & Verleger, 2013; "How much research," 2017; Kerr, 2015; Ojennus, 2015), especially in STEM classrooms, as it provides more time for interactions and active learning in the classroom.

Statement of the problem

Science, technology, engineering, and math (STEM) jobs are increasing, but STEM majors are decreasing (Chen, 2015). At the same time, the Accreditation Board for Engineering and Technology (ABET) expects schools to produce graduates with interpersonal and problem-solving skills ("Accreditation Policy," n.d.). There seems to be a need to adjust the approach to engineering education. When considering adjustments,

though, it is important to consider strategies that are proven to be effective. As Meyers (2016) explains, "Engineering educational innovation is needed nationwide; however, not every new approach is necessarily an improvement" (p. 20). Many university engineering programs are restructuring their curricula to move away from lecture and toward active learning (Meyers, 2016). As STEM education and specifically engineering curriculum becomes more common in the high school classroom, it also makes sense for high school STEM and engineering curricula to focus on active learning. One method to include more active learning in a course is to move to the flipped classroom. With the increase in technology in the classroom and the shift from teacher-centered classrooms to learner-centered classrooms, the flipped classroom model has gained ground in education (Baker, 2000). The flipped classroom is not new, but new technology has improved the technique. As Sams and Bergmann (2013), two high school teachers who are well-known for their implementation of the flipped classroom model, explain:

> For centuries, teachers have asked students to come to class prepared by reading a section of the text. The flipped learning model simply leverages new technology to provide an audiovisual option to students as they prepare for class. More important, it redefines class time as a student-centered environment. (p. 2)

In 2012, Bergman and Sams published *Flip Your Classroom: Reach Every Student in Every Class Every Day*, which indicates fifteen positive aspects of the flipped classroom. One of those touted positive effects was increased feedback in the classroom, though the authors focus more on interactions in the classroom than feedback. Much research has been conducted in recent years, which sets out to prove

or disprove the positive results that Bergmann & Sams observed in their own classroom. Research already completed on the flipped classroom shows that it provides more time for student-centered activities in the classroom (Baker, 2000; Bishop & Verleger, 2013; Blair, Maharaj, & Primus, 2015; Kostaris, Sergis, Sampson, Giannakos, & Pelliccione, 2017; Lage, Platt, & Treglia, 2000). Research has also indicated that the flipped classroom allows more time for student-student and teacher-student interactions (Baker, 2000; Carlisle, 2010; Gannod, Burge, & Helmick, 2008; Kostaris et al., 2017; Lage et al., 2000), though only one study was found that counted these interactions (Johnson & Renner, 2012). But research on student performance in the flipped classroom has been mixed (Blair et al., 2015; Carlisle, 2010; Day & Foley, 2006; Fowler, 2014; Fulton, 2012; Johnson & Renner, 2012; Kostaris et al., 2017; Mason, Shuman, & Cook, 2013; Ojennus, 2015; Sowa & Thorsen, 2015; Thai et al., 2017; Yanjie & Manu, 2017). Before a teacher commits to a new pedagogical technique, it is important to know if and why this technique is effective.

Purpose & Significance

Research on the flipped classroom, often called flipped learning or inverted classroom, has increased exponentially in recent years, as depicted in Figure 1 below. Because there are so many variables related to student success, the mixed results from research on the flipped classroom may be explained because of the variation in elements that were not directly studied. One idea shows up often in research on the flipped classroom – it gives teachers more time to interact with students and students more time to interact with each other. Many studies and anecdotal evidence indicate an increase in teacher-student and student-student interactions in the classroom, but no

research directly studied these interactions, and there is little evidence that these interactions leads to more feedback. This study will directly examine feedback in the flipped classroom.
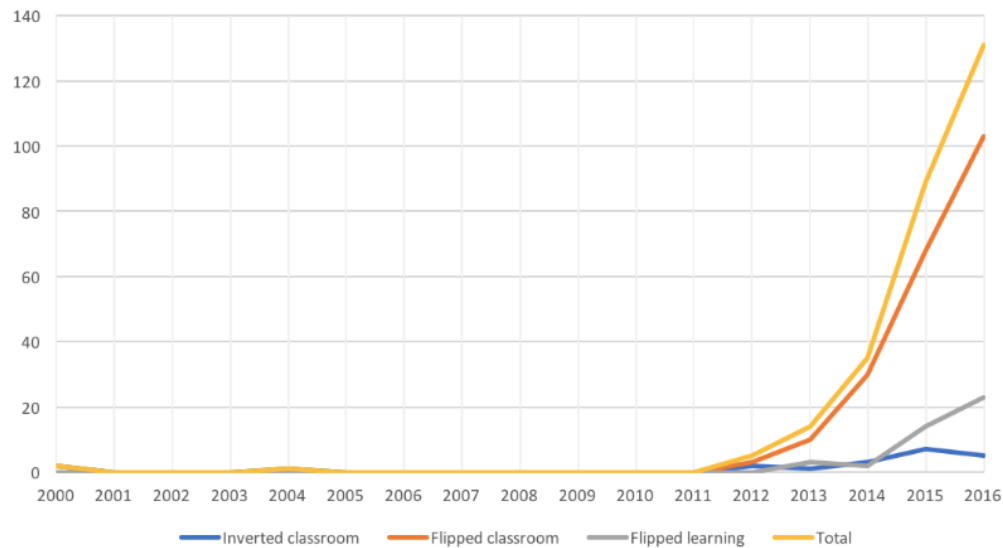
Figure 1. Number of peer-reviewed articles on flipped learning-related research. This figure illustrates the increased research on flipped classroom (inverted classroom or flipped learning) since 2012 ("How much research," 2017).

As mentioned earlier, feedback is a pedagogical technique that has proven effective in many studies (Hattie et al., 2017). If it is found that the flipped classroom model provides more time for feedback interactions, we will have a connection between this popular teaching technique and a proven pedagogical technique. These results may allow teachers a chance to more effectively implement the flipped classroom model by leveraging its potential to help deliver timely, quality feedback.

Research Questions

The study will break feedback interactions into two categories – feedback between the teacher and student and feedback among students. The researcher will

consider the number of feedback interactions and the amount of time spent in feedback interactions. The researcher will also consider the percentage of students in the class receiving feedback along with student and teacher perceptions of that feedback. The following questions will be considered:

1. Does the increased time for student-teacher interactions provided by the flipped classroom model increase the amount of feedback teachers give to students in the classroom compared to the traditional model?

H_0: There is no statistically significant difference between the amount of feedback teachers provide to students in the flipped and feedback provided by teachers to students in the traditional classroom.

2. Does the increased time for student-student interactions provided by the flipped classroom model increase the amount of feedback students give to each other in the classroom compared to the traditional model?

H_0: There is no statistically significant difference between the amount of feedback students provide to other students in the flipped classroom and feedback provided by students to other students in the traditional classroom.

3. What are student perceptions about feedback in the flipped classroom compared to feedback in the traditional classroom?

4. What are teacher perceptions about feedback in the flipped classroom compared to feedback in the traditional classroom?

CHAPTER 2: LITERATURE REVIEW

Definitions

- *Flipped Classroom* – Also referred to as the inverted classroom, the flipped classroom inverts lecture and homework. According to Bishop and Verleger, "The flipped classroom is a new pedagogical method, which employs asynchronous video lectures and practice problems as homework, and active, group-based problem-solving activities in the classroom" (2013, Abstract, para. 1). Other definitions are not as specific. Bergmann and Sams (2012) define the flipped classroom as simply moving what is traditionally done in the classroom to homework and what is traditionally done for homework to the classroom. "Flipping the classroom is more about a mindset: redirecting attention away from the teacher and putting attention on the learner and the learning" (p. 11).

- *Blended Learning* – This format is a mixture of face-to-face learning and internet-based learning (Garrison & Kanuka, 2004; Graham, Woodfield, & Harrison, 2013). Some studies consider flipped learning a type of blended learning (Thai, De Wever, & Valke, 2017).

- *Active Learning* – Active learning has a wide variety of definitions. It is contrasted with lecture in that students are actively engaged in the learning process instead of passively listening to lecture and taking notes (Freeman et. al, 2014; Prince,

2004). Prince (2004) includes collaborative learning, cooperative learning, and

problem-based learning in his study on active learning.

- *Traditional Learning* – The teacher provides instruction during class and practice

  is provided for homework. Instruction might fall into one of three categories –

  lecture, direct, or dialogic.

  - o *Lecture* -- Traditional instruction is often equated with lecture – the

    instructor conveys information while the students take notes. This form of

    instruction is efficient but not interactive (Baker, 2000; Day & Foley, 2006;

    Gough, Dejong, Grundmeyer, & Baron, 2017). More interactive forms of

    instruction are direct and dialogic instruction.

  - o *Direct* – Direct instruction is often used interchangeably with lecture and is

    similar to lecture in that the instructor conveys information and models

    problem-solving strategies. However, in direct instruction the instructor

    also provides formative assessment questions throughout instruction to

    check for understanding (Hattie et al., 2017).

  - o *Dialogic* – In dialogic instruction, students grapple with novel problems

    and are encouraged to discuss with each other ideas, potential solutions,

    and the conceptual foundation of these problems. Students develop

    perseverance, reasoning, and problem-solving skills (Hattie et al., 2017).

- *Feedback* – Information that is provided to a student by a teacher or a peer that

  is meant to help the student get closer to the learning goal.

Review of the Literature on the Flipped Classroom

The Accreditation Board for Engineering and Technology (ABET) expects engineering and technology graduates to be skilled at communication, problem-solving, and teamwork – skills which are effectively taught through active learning ("Accreditation Policy," n.d.; Felder & Brent, 2003). However, instructors still need to convey basic information. Lecture is one way to convey this basic information, and while lecture is teacher-centered, it is an efficient method for disseminating that information (Baker, 2000; Day & Foley, 2006; Gough et al., 2017). To increase active learning in the classroom, many instructors are utilizing technology to flip their instruction – making lectures homework and moving activities and applications to the classroom (Baker, 2000; Bishop & Verleger, 2013; Blair et al., 2015). In one example of instructors finding ways to create a more interactive classroom, a study was conducted on an undergraduate Material Technology course where the intention of the instructor was to find a more student-centered teaching strategy that took into consideration students that missed class. The flipped classroom was not the original goal but one that came out of the search for a pedagogical strategy that would meet the instructor's goals (Blair et al., 2015). The flipped classroom seems to meet instructors' needs to convey instructional material and create an active learning environment. As Mason, Shuman, and Cook explain:

> Engineering education should produce graduates who have good problem-
> solving skills, are able to solve open-ended problems, and have strong technical
> knowledge and an ability to learn on their own. An inverted classroom can play a
> key role in a modern engineering education by freeing time for learner-centered

activities and encouraging students to become independent self-learners. (2013, p. 434)

Not all teachers use lecture as their instructional method, though. While the study by Sowa and Thorsen (2015) is not clear on what type of instruction is being replaced with a flipped classroom – lecture, direct, or dialogic – it is a college class, and college classes often use lecture. The authors note that "[t]here are many variations in the level of engagement instructors can achieve with the lecture format, and many times instructors incorporate active learning exercises with a traditional lecture" (p. 15). Direct and dialogic instruction are more interactive, student-centered instructional methods, but the current flipped classroom research has done little to distinguish among these instructional methods. Most studies use the terms lecture and direct instruction interchangeably, and while no study mentions dialogic instruction directly, one study does seem to utilize the technique. For the purposes of this study, the researcher focused on literature related to the flipped or blended STEM class in both K-12 and higher education, then attempted to use clues in the methodology of each study to determine what type of instruction the flipped classroom was replacing. In most cases, it seemed to be lecture.

The idea of the modern flipped classroom – video lectures for homework with interactive tasks completed in class – is often credited to the high school teaching team Jonathan Bergmann and Aaron Sams (Gough et al., 2017; Jeong, González-Gómez, & Cañada-Cañada, 2016), who started flipping their own classrooms in 2007 to help absent students catch up with their work (Bergmann & Sams, 2012). Though the duo may have been the first to use the phrase "flipped classroom," the idea of a flipped or

inverted classroom has been around for much longer. Flipped-classroom studies

conducted by Lage et al. and Baker were published in 2000. In fact, even Bergmann

and Sams recognized that asking students to read ahead in the textbook is a type of

flipped classroom that has been around for ages (Sams & Bergmann, 2013).

In *Flip Your Classroom: Reach Every Student in Every Class Every Day,*

Bergmann and Sams mention many positive effects of the flipped classroom model,

which they have observed after several years of teaching with the model. Among those

benefits is an increase in teacher-student interactions and student-student interactions

in the classroom. They find that "flipping allows teachers to leverage technology to

increase interactions with students" (2012, p. 25). They check off on student work

immediately in class, having a conversation and giving mini-lectures about topics as

needed, which increases the teacher's ability to provide timely feedback. The benefit of

mini-lectures is also mentioned by Lage et al. (2000) as well as Jeong et al. (2016).

They are also able to group and re-group as needed, increasing quality student-student

interaction in class because they are not busy delivering the class material to the whole

class. Students can communicate with each other instead of depending solely on the

teacher. The flipped classroom is also better for absent students because lectures are

available at home, and it can increase parental involvement (Bergmann & Sams, 2012),

two benefits studied and agreed on by Gough et al. (2017). Sams and Bergmann do

note that "[n]opt all classrooms lend themselves to flipping. Courses that are more

Socratic or inquiry-based, or those that don't have reams of factual content for students

to learn, aren't particularly suited to flipping" (2013, p. 16). It is possible that replacing

direct or dialogic instruction with the flipped classroom might not have the same benefits

as replacing in-class lecture has. Unless otherwise noted, the studies discussed in this literature review either didn't indicate what type of instruction was replaced with the flipped classroom, or the studies directly or indirectly indicated that in-class lecture was being replaced. Of the few studies that did mention classroom structure, several indicated some combination of lecture and active learning as part of the traditional classroom, usually indicating that lecture would take up part of class and active learning would happen separately (Blair et al., 2015; Fowler, 2014; Gilboy, Heinerichs, & Pazzaglia, 2015; Kostaris et al., 2017; Roach, 2014). This structure will be referred to as "partially interactive."

Though research on the flipped classroom goes back to at least 2000, research increased exponentially after 2012 ("How much research," 2017), the year Bergmann and Sams published their book on the flipped classroom model. Despite their work focusing on secondary education, most research has been conducted in the college classroom (Baker, 2000; Bishop & Verleger, 2013; Blair et al., 2015; Carlisle, 2010; Day & Foley, 2006; Fowler, 2014; Gannod et al., 2008; Gilboy et al., 2015; Gullayanon, 2014; Heng Ngee, 2014; Jeong et al., 2016; Kerr, 2015; Lage et al., 2000; Meyers, 2016; Ojennus, 2015; Roach, 2014; Sowa & Thorsen, 2015). Only six studies were found that focused on K-12 education (Fulton, 2012; Gough et al., 2017; Johnson & Renner, 2012; Kostaris et al., 2017; Lo, 2017; Yanjie & Manu, 2017). Results from these studies are discussed in more detail throughout this chapter.

Most studies reported student perceptions of the flipped classroom, which are generally positive (Bishop & Verleger, 2013; Blair et al., 2015; Day & Foley, 2006; Fowler, 2014; Fulton, 2012; Gannod et al., 2008; Gilboy et al., 2015; Gullayanon, 2014;

Heng Ngee, 2014; Jeong et al., 2016; Kerr, 2015; Kostaris et al., 2017; Lage et al., 2000; Mason et al., 2013; Meyers, 2016; Ojennus, 2015; Roach, 2014; Sowa & Thorsen, 2015; Yanjie & Manu, 2017). The importance of student perceptions of their classroom environment is discussed in *Differentiation and the Brain: How Neuroscience Supports the Learner-Friendly Classroom* (Sousa & Tomlinson, 2011). Negative emotions will make students shut down while positive learning environments produce endorphins, "which stimulate the frontal lobe to remember the situation and whatever it is processing at the moment – most likely the learning objective" (Sousa & Tomlinson, 2011, p. 21). In a study by Jeong et al. (2016), students were asked to rate the frequency of emotions that occurred during the flipped classroom. Positive emotions were rated as more frequent than negative emotions. In a K-12 study by Kostaris et al. (2017), students in the partially interactive traditional and flipped sections rated their motivation levels in terms of attention, relevance, confidence, and satisfaction. Students in the flipped classroom rated all four areas higher and the difference in ratings between the groups was highly statistically significant, with p-values less than 0.01 In a study conducted by Meyers (2016), a traditional classroom was compared to a partially flipped classroom – a class that was flipped for some, but not all, lessons. When students were surveyed, there was a statistically significant difference in how students rated interest, effectiveness, and engagement in the traditional lecture-based course and the partially-flipped course, with the partially flipped course rating higher in all three categories. According to Ojennus (2015), students in the flipped classroom felt more comfortable with complex content. In a study by Mason et al. (2013), students in the flipped classroom felt that assessments were more appropriate than those in the traditional

classroom, even though the two groups were assessed in the same way. The authors of that study suggest that students in the flipped classroom felt better prepared for assessments than those in the traditional classroom, which was usually lecture-based but occasionally incorporated some direct instruction. Roach (2014) used a partially flipped approach for a college class that met three times a week. The first two days were spent using traditional lecture and completing the occasional application problem. The last day of the week was flipped and dedicated completely to applications. This researcher found that 76% of students said they would take another flipped class.

Several studies reported that students preferred active learning in the classroom. Lage et al., (2000) reported that students liked the collaborative aspects of the course and the in-class experiments. Similarly, Ojennus (2015) reported that students found the group work and activities in the flipped classroom useful. Carlisle (2010) conducted an interesting study on an undergraduate Introduction to Java course where three professors provided video lectures, but each professor spent a different amount of time lecturing in class. Students in all three professors' classes indicated that they preferred having time to work on programming activities during class over in-class lectures. Gilboy et al. (2015), after replacing a partially interactive traditional class model with the flipped model, found the 64% of students would rather complete in-class activities than listen to lecture. Mason et al. (2013) reported that students found the problems completed in class useful and felt the flipped classroom format was better for preparing students for engineering practice. Jeong et al. (2016) noted that "the students grant[ed] an important relevance to the more student-centered activities carried out during the face-to-face in-class time by using words such as 'hands-on, interactive or collaborative'" (p. 756). In

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fact, collaboration and interactions were cited as positive aspects in the flipped classroom in many studies (Baker, 2000; Fulton, 2012; Jeong et al., 2016; Ojennus, 2015; Roach, 2014; Yanjie & Manu, 2017).

As technology has increased in the classroom, use of video lecture as the at-home portion of the flipped classroom curriculum has become very common, and student perceptions of video lectures were often reported in recent studies. Perceptions were somewhat mixed but mostly positive. Ojennus (2015) reported that students in the flipped classroom rated the lecture, which was delivered through video, as more useful than students in the traditional classroom where lecture was delivered in class. Gilboy et al. (2015) reported that 76% of students would rather watch a video lecture than an in-class lecture, 62% of students felt they learned better from video lectures than from in-class lectures, and 70% felt connected to the instructor while watching the video lectures. In a study conducted by Mason et al. (2013), students found online videos useful, felt videos and class time contributed more to their learning than homework, and they watched the videos more often as the course progressed. Sowa and Thorsen (2015) noted that while students preferred recorded videos over text book readings, they didn't necessarily prefer recorded videos over traditional in-class lectures. This study is not clear on what type of instruction is being replaced with a flipped classroom – lecture, direct or dialogic. These authors mentioned that instructors can engage students in the learning during lecture, so it is possible that students had experienced some level of partially interactive or direct instruction. In Carlisle's study (2010), which compared the lecturing styles of three professors, in the class with the professor that lectured the least, the students reported that they watched the video lectures more

often, had more positive feelings about the videos, and reported that they felt the videos

helped them learn more. In the class with the professor that lectured the most, students

didn't watch the videos or complete the assigned reading. The author conjectured that

there was an inverse relationship between the amount of in-class lecture and the time

students spent preparing for class. The most consistent response from students was

that they liked being able to pause, rewind, and re-watch the videos. This sentiment was

repeated often in research (Fulton, 2012; Jeong et al., 2016; Mason et al., 2013;

Ojennus, 2015; Roach 2014; Yanjie & Manu, 2017).

     In *Five Best Practices for the Flipped Classroom,* Miller (2012) suggests that the

instructor must find a way to motivate students to watch videos. Students in the 2015

study by Gilboy et al. were required to complete an assignment before class. The

authors suggest that instructors monitor student progress on before-class activities to

ensure students are prepared for class, though they do not mention whether instructors

provided feedback on those before-class activities. Gullayanon (2014) and Heng Ngee

(2014) both had students complete a quiz based on the content from the video lecture

before coming to class. Gullayanon (2014) does not mention whether there was any

feedback provided on his quizzes. Students in Heng Ngee's 2014 study were able to

receive immediate feedback on their online quizzes, and the students reported positive

responses about those quizzes "because they alerted them of knowledge gaps and

prompted them to review the corresponding videos again with clear objectives" (p. 9),

indicating an increase in metacognition and self-assessment. In another study that

included online quizzes before class, students also felt the quizzes that went with the

video lectures helped them understand difficult concepts. The flipped learning materials

as a whole increased students' confidence in completing in-class materials (Jeong et al., 2016). Interestingly, Sowa and Thorsen (2015), whose students tended to prefer in-class lecture, found students did not need an incentive to watch the video, such as graded online quizzes, to be successful. Two of the K-12 studies reported using some form of at-home quiz to assess student learning from the video lectures, but these studies did not report the effectiveness of these quizzes (Kostaris et al., 2017; Lo, 2017).

Two college-level studies reported on student perceptions about the amount of work required in the flipped classroom, and those results were contradictory. In one study, students indicated that they worked slightly more in the flipped class than in their other classes (Lage et al., 2000). In a study by Mason et al. (2013), students in the flipped class indicated studying less, even though the instructors were able to cover more material. The authors postulate that students might not have interpreted watching videos as studying. Students in this study also "recognized that the new format required self-discipline and necessitated some adjustment to their study habits" (p. 433). These students found the flipped classroom frustrating at first but learned to come to class prepared and had self-regulated by week four of the study. Students in a study by Baker (2000) also felt that they had more control over their learning.

While student perceptions were mostly positive, some studies reported negative perceptions. In the review of the literature on the flipped classroom, Kerr (2015) conjectured that, in general, students may be resistant to change, and Heng Ngee's (2014) observations agreed with that conjecture. In a study by Gilboy et al. (2015), student comments brought up concerns about not being able to ask the instructor

questions during the video lectures and that other students would not come prepared for active learning in class. In a study conducted by Blair et al. (2015), two sections of an undergraduate Material Technology course were studied – one partially interactive and one flipped. Students in the flipped section indicated that they would like more "practical sessions or laboratory work," which in this setting indicated that the students "would prefer a greater focus on their own individual performance" (p. 1480). Similarly, while no student had negative comments about the flipped classroom in a study by Heng Ngee (2014), some students had complaints about the group work aspect of the class. Heng Ngee conjectured that these students preferred to work alone. One research design required college students to determine on their own which videos to watch from a pool of videos created and posted before the course began. "The intent was for students to search for information themselves in order to help develop lifelong learning skills and more closely approximate a real-world environment" (Mason et al., 2103, p. 434). Students often had trouble identifying the correct video to watch and wanted more structure in the course. These students also reported that they thought the flipped classroom model would not be effective for courses that introduce new concepts, and that they did not think college freshmen would be able to handle the flipped classroom model. The authors of this study suggest that instructors implementing flipped classroom with students not familiar with the model should incorporate more structure in their course, then gradually remove structure (Mason et al., 2013). The studies discussed above were all conducted in a higher-education setting. In a study conducted with high school students, students commented that videos could be too fast or hard to understand (Fulton, 2012).

Student perceptions in one study went unchanged. High school students in a basic computer applications course were surveyed before and after their flipped classroom experience, and analysis indicated no statistically significant difference in student attitudes about their learning experience. This anomalous result could be due to the structure of the study. Students were experiencing the flipped and traditional structure simultaneously. Some students in the same classroom were flipped while others were traditional, so the flipped students still heard the traditional in-class lecture. Students in this study were also not accustomed to having homework before the flipped structure was implemented but were required to watch video lectures at home while their class was flipped. Due to these limitations, it is possible that the results of this study are not an accurate representation of a flipped classroom model (Johnson & Renner, 2012).

Some studies reported instructor perspectives of the flipped classroom, which, like student perceptions, were mixed but generally positive. Lage et al. (2000) indicated that students seemed to take more ownership of the learning. Students were also observed learning from each other, which was corroborated in the students' positive perceptions about collaboration. The students seemed more comfortable asking questions, and more student-teacher interactions were observed. Lage et al. noted:

> From the instructor's perspective, the course was considerably more stimulating to teach. Every day was different and required active involvement with the students. Course coverage was not sacrificed, and there was more time for one-on-one interaction with students in the classroom (Lage et al., 2000, p. 37).

Ojennus (2015) also noted that the flipped classroom was better for student-teacher interactions. Both of the studies discussed above were conducted in a college setting and indirectly indicate that the flipped classroom replaced in-class lecture. If so, the perception of a more interactive course would stand to reason because lecture does not lend itself to interactivity. The most common concern from teachers was the initial time required to create videos and/or active learning activities, though most acknowledged that less preparation was required once course materials are prepared the first time (Fulton, 2012; Gilboy et al., 2015; Heng Ngee, 2014; Kerr, 2015; Lage et al., 2000; Mason et al. 2013; Ojennus, 2015).

Women are a typically underrepresented group in STEM, so a few studies reported specifically on women's perceptions in the flipped classroom. Lage et al., (2000) noted that women actively participated more than men. Women also rated the classroom experiments significantly higher than male students did. In the partially flipped Introduction to Engineering classroom described in a study by Meyers (2016), women found the classroom structure especially effective. However, in another study, when asked to rate the frequency of occurrence of certain emotions, women rated the negative emotions higher than men did (Jeong et al., 2016).

Several of the studies from K-12 education reported on teacher perspectives. Research by Gough et al. (2017) was designed to study teacher perceptions of the flipped classroom for middle and high school teachers. It is important to note that the teachers in this study were not asked what type of instruction was being replaced with the flipped classroom. These teachers said that the flipped classroom is better for absent students, and struggling students benefit from being able to re-watch video

lectures. They also reported that the flipped classroom offers more time for active learning, teacher-student interactions, and gave teachers more instructional time. It also helped improve parental involvement, though the teachers noted that parent conferences were still more about behavior than learning. Teachers in this study said they did not see an improvement in student learning nor in discipline, which contradicts Bergmann and Sams (2012), who claim that the flipped classroom will improve discipline issues. In the study where high school students experienced flipped and traditional instruction in the same class at the same time, Johnson and Renner (2012) also noted more off-task behavior was observed during flipped instruction. The teacher in this study noted that lack of student motivation was a problem, though it seems possible that the structure of the study could have been the problem. In a study at a junior high school in Greece, teachers perceived that students in the flipped classroom were more engaged than those in the partially interactive traditional model (Kostaris et al., 2017). In an action research study conducted in high school math classes, Lo (2017) noted that in his first round of study, teachers found students hesitant to collaborate, so they implemented a competition to increase collaboration. Once the students were involved in the competition, collaboration increased. Fulton (2012) also reported on flipped high school math classrooms. Students and teachers in this study appreciated that everyone had access to every teacher's video on a topic, so students could get a different perspective and teachers could learn from each other different teaching methods. These teachers, like those in other studies, also found classroom management challenging because the dynamic of the classroom had changed.

The study by Fulton (2012) also reported on parent perspectives. Based on a survey given to parents, most parents reported an overall favorable attitude toward the flipped classroom. Parent comments included that they liked that the teacher was available to help during class, and one parent noted that her child no longer needed a tutor. Parents said their children were more confident and thought the flipped classroom model was a good use of class time. Some, though, disliked the change from the way they were taught, and some disliked the technology demands of the model. Teachers in a study by Gough et al. (2017) were also concerned about technology accessibility, especially for middle school students. Bergmann and Sams (2012) offer suggestions to alleviate the technology difficulties such as making DVDs for students to view at home or allowing students to view the video lectures during class.

Three studies mention that the flipped classroom model allows instructors to increase course coverage (Baker, 2000; Lage et al., 2000; Mason et al., 2013). Lage et al. (2000) and Baker (2000) mention adding active and collaborative learning without sacrificing course coverage. In one paper, increased course coverage was studied directly. Mason et al., (2013) researched the amount of course content covered in the traditional versus the flipped classroom. The flipped course was able to cover two more topics and complete three more open-ended design problems than the traditional course.

Student performance in the flipped classroom has gotten mixed results. Seven studies reported that students performed better in the flipped classroom (Carlisle, 2010; Day & Foley, 2006; Fulton, 2012; Gullayanon, 2014; Kostaris et al., 2017; Mason et al., 2013). In one of these studies, two sections of an 8th-grade equivalent information and

communication technology (ICT) course in Greece were studied, one flipped and one partially interactive traditional. Four assessments were used to study student performance. A diagnostic test was used to show there was no statistically significant difference in prior knowledge between the two sections. The flipped section showed higher student performance on the three assessments given during the term, with a statistically significant higher performance on assessments 2 and 3. The authors note that the benefits of the flipped classroom model increased as the course progressed. Since the authors do not indicate that the first test was more or less difficult than the last two tests, one possible reason for the increase is that participants were growing more comfortable with the model. The results from this study also showed that the flipped classroom was best for low-performing students (Kostaris et al., 2017). Two sections of an undergraduate engineering course were compared in a study by Mason et al. (2013). One section received traditional instruction that was usually lecture-based but occasionally incorporated direct instruction, and one section received flipped instruction. Seven problem groups and design problems were considered. The flipped group performed better (statistically significant) on three problem sets and design problems, but the two groups were similar on all other problem sets, showing that the flipped classroom is at least not detrimental to learning outcomes (Mason et al., 2013).

Students in the flipped and traditional models showing similar performance or performing strong in one area but weaker in another was a common theme in seven studies (Blair et al., 2015; Fowler, 2014; Johnson & Renner, 2012; Ojennus, 2015; Sowa & Thorsen, 2015; Thai et al., 2017; Yanjie & Manu, 2017). Johnson and Renner (2012) noted that there was no statistically significant difference between the students in

the flipped and traditional models. Though the structure of that study – students in the

same class experiencing the flipped and traditional models simultaneously – could be to

blame. Fowler (2014) studied two sections of an undergraduate engineering course.

The course met for four hours each week. In the traditional course, three hours was

dedicated to lecture while one hour was set aside for applications. In the flipped course,

all four hours were dedicated to applications each week. Fowler found that student

performance in the flipped course increased in problem-solving but decreased on

conceptual skills. The author notes that "[t]his may be due to the flipped classroom

driving students toward the view that if they can 'do' the problems they don't need to

'understand' the concepts" (p. 2222). Based on post-test scores for two sections of an

undergraduate biochemistry course, one taught using the flipped classroom model and

one using a traditional model, the researchers in another study found no statistically

significant difference in student performance, thus the flipped classroom model did not

seem to improve learning. However, based on learning gains measured in pre- and

post-test assessments, the researchers conjectured that the flipped classroom might be

better for lower-performing students because the students in the flipped classroom that

had the highest learning gains were the students that did not obtain the highest course

marks (Ojennus, 2015). Blair et al. (2015) found no evidence to indicate increased

student performance in the flipped classroom; in fact, the percentage of students that

received the highest marks in the class decreased in the flipped classroom model

compared the partially interactive traditional model. Sowa and Thorsen (2015)

concluded that student performance either improved or at least stayed the same in the

flipped courses. In a study conducted by Carlisle (2010), which compared three flipped

classrooms with differing amounts of lecture, students in the class with the least lecture performed the best, but the difference in performance among the three groups was not statistically significant

An interesting study by Thai et al. (2017) compared four learning structures that they called blended, traditional, e-learning, and flipped, though their definitions of these models do not reflect the most common definitions. In the blended learning model, students received the lecture in class and completed the exercises outside of class. Their blended model most closely matches the standard definition of the traditional model. In their traditional learning model, lecture and exercises were completed in class. In the e-learning model, lecture and exercises were completed online. In the flipped model, students were given web-based lectures before class and had to solve exercises individually during class, which also contradicts the standard definition of the flipped class since flipping typically emphasizes collaboration. Students in the flipped model performed significantly better than in the e-learning and traditional model, though flipped-model students and blended-model students performed about the same. The authors hypothesize that the flipped-model students outperformed the traditional-model students because the flipped-model students had lectures online, giving them the opportunity to pause, re-watch, and learn at their own pace. However, the fact that the flipped-model students performed about the same as the blended-model students, which is more like the traditional model studied in other research, leads one to conclude that performance in a standard flipped model is about the same as performance in a standard traditional model (Thai et al., 2017).

A study conducted in Hong Kong with 11- and 12-year-old students on a polynomials unit compared a "productive failure" flipped classroom with a "traditional" flipped classroom. This study is especially interesting because most studies seem to use lecture or possibly direct instruction, though studies don't explain the method of instruction used and often seem to conflate lecture with direct instruction. This study is the only research that seems to utilize dialogic instruction. Students in the productive failure model grappled with problems collaboratively during class, then watched a video to consolidate the new material at home afterwards. Students in the traditional flipped class watched a video on the concepts before class, then worked collaboratively on problem-solving exercises during class. 53.8% of the traditional flip students watched videos two or more times; 42.9% of the productive failure students watched videos two or more times. The authors conjecture that the productive failure students had some understanding of the concept before watching the video, thus only needed to watch it once. Students in the productive failure model found collaboration to be the most important aspect of the pedagogical model while students in the traditional flipped classroom liked the interactions they had with teachers and other students. In terms of student performance, the traditional flip students seemed to perform better on procedural knowledge, but the productive struggle students performed significantly better on conceptual knowledge (Yanjie & Manu, 2017).

Because this research study will focus on feedback interactions, special care was taken to review the literature on the flipped classroom for teacher-student and student-student interactions. In one of the early research studies on the flipped classroom,

conducted in an undergraduate economics course, Lage et al. (2000) noted the

following:

> One of the strengths of the inverted classroom is the opportunity for faculty-
> student interaction. This interaction is beneficial in two ways: the student is able
> to clear up any confusion immediately, and the instructor is able to monitor
> performance and comprehension. (p. 37)

The same could be said of dialogic or direct instruction, though. In a student survey

conducted by Baker (2000), another early researcher on the flipped classroom in higher

education, students indicated more one-on-one time in the classroom. The instructor

noted that the class discussion board allowed students to learn from each other and

encouraged them to think critically; students were able to collaborate more in the

classroom. In a more recent action research study conducted by Kostaris et al. (2017)

with middle school students which compared flipped instruction with partially interactive

traditional instruction, researchers found that in the flipped classroom model, more time

was spent in hands-on activities, student-student collaboration, and student-teacher

interactions. Low performing students in this study saw the most gains, and researchers

conjectured that these games could "be attributed to the capacity of students to receive

formative feedback and scaffolding during face-to-face sessions, both from their teacher

as well as from their classmates" (p. 270).

The ability of the instructor to give feedback to students or students to collaborate

and give feedback to each other was a recurring theme throughout the literature. Gilboy

et al. (2015), in their work with undergraduate nutrition students, noted "[t]he instructor

monitored the process throughout and was able to guide student thinking as well as

clarify misconceptions or incorrect information" (p. 112). In the productive failure study

conducted by Yanjie and Manu (2017) with middle school students, the instructors used

an online feedback system and tablets with screen-sharing capability, so students could

get feedback from the instructors and from peers. Students in the traditional flipped

model said that the help they received from teachers and peers was the most important

aspect of their model while students in the productive failure model said collaboration

with peers was the most important aspect of their model. Gannod et al. (2008) noted the

ability to give immediate feedback to their undergraduate software engineering students

as a positive of the flipped classroom but did not do research to back up that claim.

Fulton (2012) provides a compelling illustration of feedback being used in a high school

flipped calculus classroom:

> [The teacher] moves from student to student, watching, listening, noting who
>
> needs help. If several students are stuck on a problem, he might work through
>
> more examples on the board at the front of the class. And, just to be sure, there
>
> are daily spot quizzes, often using clickers so the students and teacher get
>
> immediate results. The feedback allows for group discussion and peer instruction
>
> on the problems that many students are struggling with and helps [the teacher]
>
> and his colleagues target – and revise in real time – instruction on concepts that
>
> students find difficult (p. 13).

Again, this type of feedback could be possible in a class using direct or dialogic

instruction, though the amount of feedback might not be equivalent to that possible in

the flipped classroom.

Overall, perceptions by all concerned parties – students, teachers, and parents – in the flipped classroom are mostly positive. While performance in the flipped classroom has gotten mixed results, students in most flipped classrooms did at least as well as students in the traditional classroom, with several studies reporting improved performance in the flipped model. Considering the flipped classrooms seems to provide ample opportunity for interactions and feedback, this instructional model seems like a worthwhile approach to continue studying.

CHAPTER 3: METHODOLOGY

Purpose & Research Questions

The purpose of this study is to examine feedback in the flipped high school STEM classroom. Many studies indicated that the flipped classroom provides more time for interactions between the teacher and students and among students, though these interactions have not been studied directly. Thus, there is no clear evidence that these interactions provide more feedback in the classroom. This study aimed to identify feedback interactions and compare those interactions in a flipped classroom and a traditional classroom. For the purposes of this study, feedback interactions are defined to be information provided to a student by the teacher or a peer that is meant to help the student get closer to the learning goal.

The study separated feedback interactions into two categories – feedback between the teacher and student and feedback among students. The quantitative portion of this research considered the number of feedback interactions and the amount of time spent in feedback interactions. The researcher also considered the percentage of students in the class receiving feedback. In the qualitative portion, the researcher studied student and teacher perceptions of feedback in both a flipped and traditional classroom. The following questions were considered:

1. Does the increased time for student-teacher interactions provided by the flipped classroom model increase the amount of feedback teachers give to students in the classroom compared to the traditional model?

H_0: There is no statistically significant difference between the amount of feedback teachers provide to students in the flipped and feedback provided by teachers to students in the traditional classroom.

2. Does the increased time for student-student interactions provided by the flipped classroom model increase the amount of feedback students give to each other in the classroom compared to the traditional model?

H_0: There is no statistically significant difference between the amount of feedback students provide to other students in the flipped classroom and feedback provided by students to other students in the traditional classroom.

3. What are student perceptions about feedback in the flipped classroom compared to feedback in the traditional classroom?

4. What are teacher perceptions about feedback in the flipped classroom compared to feedback in the traditional classroom?

Population & Sampling

The target population for this study was STEM students at a particular high school in suburban Mississippi with 24% of students on free or reduced lunch. The demographic breakdown of the population and sample can be see below in Table 1. Because all students at this high school are required to take a science and a mathematics course each year of high school, the demographics for STEM students are

very similar to the demographics for the school, though a small percentage of students

may take more than one science and/or math class, and students can also take

engineering and technology electives. A convenient sample was taken. The main

sample studied was two sections of the researcher's Principles of Engineering classes.

The researcher also studied a section of Advanced Placement (AP) Statistics taught by

another teacher at this high school. Both of these courses are STEM electives, and

though AP Statistics can be used as a mathematics credit, students often take this

course along with another mathematics course.

Table 1

Population and Sample Demographics

Gender	All (n=1636)	STEM (n=4267)	Stats (n=12)	POE 1 (n=17)	POE 2 (n=14)	POE All (n=31)
Male	50.2%	49.4%	91.7%	64.7%	78.6%	71.0%
Female	49.8%	50.6%	8.3%	35.3%	21.4%	29.0%
Race/Ethnicity						
Asian	3.9%	4.5%	33.3%	17.6%	14.3%	16.1%
Black	26.7%	25.3%	8.3%	23.5%	14.3%	19.4%
Hispanic/Latino	3.7%	3.6%	16.7%	0.0%	21.4%	9.7%
Native American	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%
Two or More	1.1%	1.2%	0.0%	5.9%	0.0%	3.2%
White	64.5%	65.2%	41.7%	52.9%	50.0%	51.6%
Grade						
9th grade	28.3%	32.6%	0.0%	0.0%	0.0%	0.0%
10th grade	25.0%	24.6%	0.0%	70.6%	92.9%	80.6%
11th grade	25.1%	22.9%	50.0%	23.5%	7.1%	16.1%
12th grade	21.6%	20.2%	50.0%	5.9%	0.0%	3.2%

Note. All = all students at this high school. STEM = students in science, technology, engineering, and math courses. Stats = students in AP Statistics participating in this study. POE 1 = students in section 1 of principles of engineering participating in this study. POE 2 = students in section 2 of principles of engineeirng participating in this study. POE ALL = students in section 1 and 2 of principles of engineering participating in this study.

Principles of Engineering (POE) sample. Principles of Engineering is a course for students in their second year of a high school engineering academy – a four-year set of courses designed to prepare students to major in a STEM field in college. Two sections of POE were studied, referred to as POE 1 and POE 2. POE 1 has 18 students and POE 2 has 21. Of those students, 31 agreed to participate in the study, 17 from POE 1 and 14 from POE 2. As shown in Table 1, the demographic makeup of the POE participants differs from the STEM student population at this high school, but the most striking difference is the percentage of female students, with only 29% of the students in POE being female. As of 2011, women made up 24% of the STEM workforce (Beede, Julian, McKittrick, Khan, & Doms, 2011), so this number is fairly representative of females in STEM.

Three students from POE agreed to be interviewed. Psuedonyms are used to protect their identity. Amy is Asian, female and a 10th-grader in POE 2 that typically does her video assignments on time. She is ambivalent about the flipped classroom model. Rory is male, white, and a 10th-grader in POE 1 that occassionally watches his video assignments late, but is usually a responsible student. Rory likes the flipped classroom model. Jack is male, white, and a 10th-grader in POE 2 that always completes assignments on time. He has expressed a dislike of the flipped classroom. All three of these students have averages in the top third of their class. The researcher requested interviews from other students with differing demographics and class averages, but these students did not agree to be interviewed.

The majority of the study was focused on the two POE classes. The study was completed during the second semester of the school year. The students at this high

school are on an A/B Block schedule, which means these POE courses meet all year long every other school day. The instructor/researcher used a flipped model during the first semester in all her engineering courses. The online video lesson platform Edpuzzle was used to deliver course content, and class time was used for students to complete activities and projects based on this content. Edpuzzle allows teachers to create and upload their own videos or choose from videos created by other instructors, including videos on YouTube and Khan Academy. A mixture of self-made videos and videos made by others are typically used in POE. Edpuzzle also allows teachers to include formative questions throughout the video and reports performance information for students as they complete video lessons, thus providing at-home feedback. The instructor/researcher utilizes this formative assessment tool and uses these grades as formative assessment grades. Student are allowed to re-watch video lessons for a better grade and to email the instructor with questions after school hours.

AP Statistics sample. At the researcher's high school, there is only one section of AP Statistics with 13 students, 12 of which agreed to participate in this research study. The teacher also agreed to participate and be interviewed. The teacher's pseudonym for the study is Mrs. Hiddleston. As shown in Table 1 above, of the students that agreed to participate in the survey, only 8.3% are female, which is not representative of typical STEM interest by females. Other demographics in this sample also vary greatly from the larger STEM population.

Mrs. Hiddleston uses a blended instructional method – incorporating traditional and flipped instruction into her lessons. Like the researcher, Mrs. Hiddleston uses Edpuzzle to deliver video lectures for flipped lessons. She also uses formative

questions throughout her videos. Unlike the researcher Mrs. Hiddleston grades her

students on completion of the video, not accuracy, thus the students do not need to re-

watch videos to improve their grade.

Table 2

Analysis of Variance of First Semester Averages in AP Statistics, POE 1 and POE 2.

Source	df	SS	MS	F	p
Between Groups	2	520.80	260.40	1.25	.30
Within Groups	40	8333.06	208.33		
Total	42	8853.86			

Note. There is no statistically significant difference in the first semester averages of the three classes.

To compare the AP Statistics and two POE classes academically, the researcher

asked Mrs. Hiddleston to provide first semester averages. Mrs. Hiddleston removed

student names from this data to keep the data anonymous. While it is possible for

students to take both AP Statistics and POE in the same year, no students in the

classes overlapped. The researcher performed an ANOVA test on the data, the results

of which are available in Table 2 above. The test showed that there was no statistically

significant difference among the first semester averages in these three classes.

Because these three classes are academically similar, it may be reasonable to expect

that they will receive similar amounts of feedback during the study. However, there are

many more elements that affect interactions in the class, such as attitudes, personality,

group partners, and work ethic, so it would be inappropriate to assume too much based

on these results.

Procedure & Time Frame – Principles of Engineering

For POE, the study began March 2, 2018 and went through May 16, 2018. POE1 was taught a unit on statics using the traditional lecture format while POE 2 was taught statics using the flipped format. Because some of the activities completed during the unit could not be done at home, the traditional lecture format took longer to complete, so POE 2 began the second unit before both sections were assessed on unit 1 on April 12, 2018. For the second unit of study, material properties, POE 1 received flipped instruction while POE 2 received traditional instruction. While traditional instruction took longer than flipped instruction again, POE 1 caught up with POE 2 and both were assessed on April 30. The two sections completed the same activities throughout the units.

During the study, the researcher filmed three key lessons in each unit, focusing on thirty minutes of each lesson. The class block is 95 minutes long, and each class starts with an opener that takes 30 minutes on average, though it can take longer if students are struggling with the material. Because an opener is standard in all classes, both traditional and flipped, the researcher wanted to avoid looking for interactions during that time, though it wasn't always possible. The goal was to observe 30 minutes of class during the main task planned for that day, but due to interruptions such as announcements, the time it took to set up and export the video recordings, and the length of the opener, time from the opener was occasionally used for observation. Students were put into groups, and computers with a built-in camera were set up at each group to record student-student and teacher-student interactions. Groups were changed for each activity. A computer was also set up to film the class as a whole. After

each day of recording, the videos were transferred directly from each computer to the researcher's password-protected Google drive, then deleted from the computer.

The researcher analyzed the recordings, counting and timing feedback interactions among students and between the teacher and students. Feedback interactions were timed from the initial question/prompt for feedback until the student receiving the feedback acknowledged an understanding of the feedback either verbally or by returning to work on the task. Feedback interactions that included inaccurate information were not counted. Occasionally, though rarely, it was difficult to hear the details of an interaction on the video recording, so these interactions were not counted as feedback. If two or more students clearly received feedback from the same interaction, that feedback was counted for both students.

After completion of the two units of study, students that agreed to participate in research were given an optional, anonymous survey to complete to share their perceptions of feedback in the flipped and traditional classroom. The survey was conducted via Google Forms. Students were provided with a link to the survey during class and given time to complete it during class. No identifying information was requested on this survey. A copy of the survey is provided in Appendix F. All surveys were completed by April 26, 2018. Of the 31 students that agreed to participate in research, 23 submitted surveys. Of those that submitted surveys, 22 completed all questions on the survey and one student completed all but the one open-answer question.

In order to gather qualitative data on student perceptions of the flipped classroom, the researcher/instructor asked three students to participate in an interview.

Those students, described above in the population and sample subsection, gave interviews on May 11th, May 15th, and May 16th, either before school or during a free block. Each interview lasted approximately 10 minutes. A copy of the original interview questions is provided in Appendix G. A copy of the interview transcripts is provided in Appendices H, I, and J.

Procedure & Time Frame – AP Statistics

The researcher requested to film one flipped lesson of AP Statistics on March 6, 2018. The same format as filming in the POE classes was used for filming AP Statistics – setting up a computer to video record each group and one to video record the whole class. The researcher analyzed thirty minutes of the videos to count and time student-student and teacher-student feedback interactions using the same criteria described for POE. Students were given the same survey as the POE students and asked to complete it by April 6, 2018. These students were provided a link to the Google Form survey via email and completed the survey outside of class. Of the 12 students participating in research, eight completed the survey. Mrs. Hiddleston was interviewed on May 18, 2018 during a free block that she and the researcher shared. The original teacher interview questions can be found in Appendix K, and the interview transcript can be found in Appendix L.

Analysis Plan

After reviewing the recordings from the two POE sections, the researcher had quantitative data on the number and time of feedback interactions during class for each student. Since three flipped lessons and three traditional lessons were recorded, the researcher took averages from the flipped lessons and averages from the traditional

lessons, so that for each student there is an average number of feedback interactions and an average time spent receiving feedback interactions each day in class, separated by teacher-student, student-student, and the sum of the two. A paired t-test with a critical alpha level of 0.05 was used to compare this data for each section, comparing the flipped lessons in one section to the traditional lessons in the same section. The researcher also noted the percentage of students receiving feedback during the lessons and compared the percentage of students receiving feedback in the traditional lessons versus the flipped lessons in each section to see which value was higher.

The researcher also collected quantitative data from the AP Statistics class on number of feedback interactions, time of feedback interactions, and percentage of student receiving feedback for the one recorded lesson. Using an ANOVA, the researcher compared quantity and time of feedback in the flipped lessons among POE 1, POE 2 and AP Statistics. This comparison allowed the researcher to determine if the amount and time of feedback interactions in her class are representative of other teachers that used a flipped classroom model. The researcher then directly compared the percentage of students receiving feedback in AP Statistics to the percentages recorded for the two POE sections to see how comparable these numbers were.

Survey results from students about their perceptions of feedback in the flipped versus traditional classroom provided information about student perceptions of feedback in the flipped classroom. One question on the survey was open-answer, giving students a chance to share their perspectives on the flipped classroom in general. This question was intentionally asked first because the researcher was concerned that the Likert scale questions about interactions and feedback in the classroom might sway student

responses. The results from the open answer question were coded using Dedoose software and analyzed for patterns that might shed light on the quantitative data gathered in this study.

Interviews and research notes taken during interviews, during and after recorded lessons class, and while watching recordings yielded qualitative results. The researcher took notes during the interviews and transcribed the interviews to fully analyze the data. The researcher also took quick notes during class when lessons were filmed, then wrote more thorough notes after class and while watching the recorded lessons. These results were also coded using Dedoose software, looking for patterns in the information that might shed light on the student and teacher perceptions of feedback or provide additional meaning to the quantitative results.

Validity & Reliability

Considering the number of interactions in a classroom, the researcher chose to video record interactions instead of relying on observation to ensure validity of the results. Without recordings, there would be many missed interactions. This allowed the researcher to instruct her classes as normal. Also, the time spent writing down observations could have taken away from time spent in feedback interactions. To ensure validity in surveys and interviews, these questions were reviewed by peers and advisors.

Because students might act differently when on film, the researcher did some test-filming in her POE classes before the research began so that students could become comfortable with the filming process. AP Statistics was not test-recorded, though, so those students may not have been as comfortable being recorded as the

POE students. The researcher also emphasized that nothing on film would affect a student's grade in the class.

To ensure reliability of results, the researcher chose to video several days of instruction in her POE classes. Because one lesson can vary greatly from another, studying several days can give a better picture of what might happen on an average day. Because the researcher would be focused on feedback, filming one flipped lesson from another teacher was also done to ensure reliability of the study.

Scope & Limitations

There are several limitations to consider in this research study. Despite conducting test filming to alleviate the problem, students may not have acted naturally while being recorded. On the survey, students were asked to self-report their perceptions and may not have answered honestly or accurately. This problem may also have occurred during student and teacher interviews. Because the researcher was focused on feedback, more feedback than normal may have been given. However, because each POE section is being compared to itself, the increase in feedback should balance out. Also, by filming another teacher and comparing her use of feedback to feedback given in the POE classes, the researcher can put her own use of feedback into perspective. Another potential problem was that students not participating in research might get significantly more or less feedback than the average student, which could potentially change the results. Finally, while recordings were used to count and time feedback interactions, some interactions were missed or may have been misinterpreted because of background noise, students talking over each other, and students speaking too quietly to understand.

CHAPTER 4: RESULTS

The purpose of this study is to examine feedback in the flipped classroom. In this study, feedback is defined as information that is provided to a student by a teacher or a peer that is meant to help the student get closer to the learning goal. The researcher considered the number of feedback interactions and the amount of time, measured in seconds, spent in feedback interactions between the teacher and students and among students. The first section will present the quantitative data gathered to address research questions one and two. The researcher also collected data on student and teacher perceptions of interactions in the flipped classroom and the flipped classroom in general in order to address research questions three and four. That data is presented in the second section of this chapter.

Quantitative Data on Feedback Interactions

Research Questions

1. Does the increased time for student-teacher interactions provided by the flipped classroom model increase the amount of feedback teachers give to students in the classroom compared to the traditional model?

H_0: There is no statistically significant difference between the amount of feedback teachers provide to students in the flipped and feedback provided by teachers to students in the traditional classroom.

2. Does the increased time for student-student interactions provided by the

flipped classroom model increase the amount of feedback students give to

each other in the classroom compared to the traditional model?

H_0: There is no statistically significant difference between the amount of feedback

students provide to other students in the flipped classroom and feedback

provided by students to other students in the traditional classroom.

Students in two sections of Principles of Engineering (POE 1 and POE 2) were

video recorded for three days during a flipped unit of study and three days during a

traditional unit of study. The researcher counted and timed feedback interactions for

each student participant via the video recordings, then calculated the average number

of feedback interactions and the average time spent in feedback interactions for each

student during the flipped unit of study and traditional unit of study. This data can be

found in Appendix M. A paired t-test was performed on the average number of feedback

interactions and average time of feedback interactions, broken down by teacher-student

interactions, student-student interactions, and the sum of the two. The results of these

tests are summarized in Tables 3-5 below.

Table 3

Teacher-Student Feedback Interactions Per Student

Class	Average Number of Interactions		*t*	*df*	*p*
	Flipped	Traditional			
POE 1	0.71	1.11	1.71	16	0.107
POE 1[a]	0.75	1.15	1.58	15	0.135
POE 2	1.37	0.25	8.19	13	0.000
POE 2[a]	1.30	0.30	5.82	9	0.000

Class	Average Time of Interactions		*t*	*df*	*p*
	Flipped	Traditional			
POE 1	23.84	24.73	0.10	16	0.922
POE 1[a]	25.33	26.12	0.08	15	0.935
POE 2	52.24	5.64	5.98	13	0.000
POE 2[a]	49.37	7.30	4.80	9	0.001

Note. Time is measured in seconds.
[a] Students who were absent for one day during filming were removed from this data. No participating students were absent for more than one day during each unit.

As shown in Table 3 above, for POE 1, there were more teacher-student feedback interactions in the traditional classroom, with p = .107 and p = .135. However, the average time spent in teacher-student feedback interactions was similar for flipped and traditional instruction, with p = .922 and p = .935. For POE 2 the average number and time spent in teacher-student feedback interactions was higher for the flipped classroom, with p < .01 in all cases.

Table 4

Student-Student Feedback Interactions Per Student

	Average Number of Interactions				
Class	Flipped	Traditional	*t*	*df*	*p*
POE 1	1.51	1.25	0.61	16	0.552
POE 1[a]	1.52	1.33	0.43	15	0.676
POE 2	2.00	0.56	3.08	13	0.009
POE 2[a]	1.93	0.68	2.25	9	0.051
	Average Time of Interactions				
Class	Flipped	Traditional	*t*	*df*	*p*
POE 1	30.12	18.67	1.25	16	0.231
POE 1[a]	31.02	19.83	1.14	15	0.271
POE 2	55.44	14.27	2.72	13	0.018
POE 2[a]	57.20	16.97	2.03	9	0.073

Note. Time is measured in seconds.

[a] Students who were absent for one day during filming were removed from this data. No participating students were absent for more than one day during each unit.

The number of student-student feedback interactions was approximately the same in the traditional and flipped classes in POE 1, with p = .552 and p = .676, as shown in Table 4 above. However, the duration of student-student feedback interactions in the flipped classroom was higher than the traditional classroom, with p = .231 and p = .271. For POE 2, there were more and longer student-student feedback interactions in the flipped classroom, with p between .009 and .073.

Table 5

Sum of Teacher-Student and Student-Student Feedback Interactions Per Student

| | Average Number of Interactions | | | | |
Class	Flipped	Traditional	*t*	*df*	*p*
POE 1	2.22	2.36	0.27	16	0.790
POE 1[a]	2.27	2.48	0.36	15	0.723
POE 2	3.14	0.79	4.99	13	0.000
POE 2[a]	3.23	0.97	3.53	9	0.006
	Average Time of Interactions				
Class	Flipped	Traditional	*t*	*df*	*p*
POE 1	53.96	43.40	0.85	16	0.406
POE 1[a]	56.35	45.96	0.79	15	0.442
POE 2	99.45	19.38	4.72	13	0.000
POE 2[a]	106.57	24.27	3.62	9	0.006

Note. Time is measured in seconds.
[a] Students who were absent for one day during filming were removed from this data. No participating students were absent for more than one day during each unit.

According to Table 5 above, for POE 1, the number and length of feedback interactions overall was approximately the same for both flipped and traditional instruction, with p between .406 and .790. For POE 2, however, there were more and longer feedback interactions in the flipped classroom model, with p < .01.

Because of the difference in results between POE 1 and POE 2, the researcher considered the differences in the two units taught during this research study. Unit 1 was taught traditionally for POE 1 and flipped for POE 2, then Unit 2 was flipped for POE 1 and taught traditionally for POE 2. To determine if a unit was more or less likely to elicit feedback, the researcher compared the number and time of feedback interactions for each unit of study. An unpaired t-test was used to compare the average feedback interactions for each unit, broken down by teacher-student feedback, student-student feedback, and the sum of these feedback interactions. The results are summarized in Tables 6-8 below.

Table 6

Teacher-Student Feedback Interactions Per Student for Each Unit of Study

| Average Number of Interactions | | | | |
Unit 1	Unit 2	*t*	*df*	*p*
1.22	0.50	3.77	60	0.000
1.25[a]	0.54[a]	3.40	54	0.001

| Average Time of Interactions | | | | |
Unit 1	Unit 2	*t*	*df*	*p*
37.16	15.62	2.78	60	0.007
35.08[a]	17.08[a]	2.24	54	0.029

Note: Time is measure in seconds.
[a] Students who were absent for one day during filming were removed from this data. No participating students were absent for more than one day during each unit.

As shown in Table 6 above, the average number and time of teacher-student feedback interactions were higher in Unit 1 than in Unit 2, regardless of whether the lessons were taught traditionally or flipped, with p < .05.

Table 7

Student-Student Feedback Interactions Per Student for Each Unit of Study

| Average Number of Interactions | | | | |
Unit 1	Unit 2	*t*	*df*	*p*
1.59	1.08	1.46	60	0.150
1.51[a]	1.18[a]	0.92	54	0.363

| Average Time of Interactions | | | | |
Unit 1	Unit 2	*t*	*df*	*p*
35.27	22.96	1.33	60	0.188
43.33[a]	27.50[a]	0.81	54	0.422

Note: Time is measure in seconds.
[a] Students who were absent for one day during filming were removed from this data. No participating students were absent for more than one day during each unit.

Table 7 above shows that when students who were absent for one day of filming were included in the data, the average number and time of student-student feedback

interactions are higher in Unit 1 than in Unit 2, with p = .150 and p = .188. Removing

students that were absent for one day during the unit changed the results so that the

amount and time of student-student feedback interactions in the flipped and traditional

models are approximately equal, with p = .363 and p = .422.

Table 8

All Feedback Interactions Per Student for Each Unit of Study

Average Number of Interactions				
Unit 1	Unit 2	*t*	*df*	*p*
2.71	1.57	2.77	60	0.008
2.76[a]	1.71[a]	2.38	54	0.021

Average Time of Interactions				
Unit 1	Unit 2	*t*	*df*	*p*
68.72	38.34	2.40	60	0.020
67.76[a]	41.92[a]	1.93	54	0.060

Note: Time is measure in seconds.
[a] Students who were absent for one day during filming were removed from this data.
No participating students were absent for more than one day during each unit.

As expected, based on the data in Tables 6 and 7, Table 8 shows that the

average number and time of all feedback interactions are higher in Unit 1 than in Unit 2,

with p between .008 and .060.

A flipped lesson in an AP Statistics class at the same school taught by a different

teacher was recorded to determine if the feedback interactions in the flipped POE

classes were representative of feedback received by students in any flipped STEM

class. An ANOVA was used to compare the number and length of feedback

interactions, broken down by teacher-student, student-student, and the sum of the two.

The results of these tests are presented in Table 9 below.

Table 9

Analysis of Variance of Feedback Interactions in POE 1, POE 2, and AP Statistics

Teacher-Student Interactions

Number	df	SS	MS	F	p
Between	2	11.46	5.73	5.30	0.009
Within	39	42.17	1.08		
Total	41	53.63			

Duration	df	SS	MS	F	p
Between	2	126838.14	63419.07	10.20	0.000
Within	39	242452.86	6216.74		
Total	41	369291.00			

Student-Student Interactions

Number	df	SS	MS	F	p
Between	2	14.92	7.46	2.90	0.067
Within	39	100.19	2.57		
Total	41	115.11			

Duration	df	SS	MS	F	p
Between	2	5757.68	2878.84	1.45	0.246
Within	39	77253.68	1980.86		
Total	41	83011.36			

All Interactions

Number	df	SS	MS	F	p
Between	2	46.57	23.29	8.08	0.001
Within	39	112.45	2.88		
Total	41	159.02			

Duration	df	SS	MS	F	p
Between	2	172260.73	86130.37	10.14	0.000
Within	39	331430.78	8498.23		
Total	41	503691.51			

Note. Time is measure in seconds.

A Tukey-Kramer HSD Post-Hoc test was performed after each ANOVA test, and the results are shown in Table 10 below. In most cases there was a significant difference between POE 1 and AP Statistics, with AP Statistics having increased interactions in all cases. When considering the time spent in teacher-student feedback

interactions and the number and time spent of all feedback interactions, the difference

between POE 2 and AP Statistics was also significant, again with AP Statistics having

more interactions.

Table 10

Tukey-Kramer HSD Post-Hoc Test

Number of Teacher-Student Interactions		Time of Teacher-Student Interactions	
Classes	p	Classes	p
POE 1 vs POE 2	0.258	POE 1 vs POE 2	0.630
POE 1 vs AP Statistics	0.007	POE 1 vs AP Statistics	0.000
POE 2 vs AP Statistics	0.224	POE 2 vs AP Statistics	0.004

Number of Student-Student Interactions		Time of Student-Student Interactions	
Classes	p	Classes	p
POE 1 vs POE 2	0.676	POE 1 vs POE 2	0.326
POE 1 vs AP Statistics	0.054	POE 1 vs AP Statistics	0.339
POE 2 vs AP Statistics	0.280	POE 2 vs AP Statistics	0.997

Number of All Interactions		Time of All Interactions	
Classes	p	Classes	p
POE 1 vs POE 2	0.375	POE 1 vs POE 2	0.427
POE 1 vs AP Statistics	0.001	POE 1 vs AP Statistics	0.000
POE 2 vs AP Statistics	0.032	POE 2 vs AP Statistics	0.009

Finally, the researcher compared the percentage of students present receiving

feedback from the teacher, from other students, and the combination of the two. To

calculate this percentage, the researcher first tallied the number of students that

received feedback each day. Then the percentage of students receiving feedback each

day was calculated. An average of those percentages for flipped lessons and for

traditional lessons was calculated, and the results are summarized below in Table 11.

For POE 1, a higher percentage of students received student feedback in the flipped model, a higher percentage received teacher feedback in the traditional model, but about the same percentage of students receiving feedback from either a student or teacher in both models. For POE 2, a much higher percentage of students received feedback in the flipped model regardless of the source. Comparing the POE classes to the one AP Statistics class observed, higher percentage of students in AP Statistics received feedback in every category.

Table 11

Average Percentage of Students Receiving Feedback

Class	Flipped			Traditional		
	Student	Teacher	Either	Student	Teacher	Either
POE 1	58.8%	45.1%	78.4%	48.4%	59.8%	76.1%
POE 2	61.1%	65.5%	78.6%	25.6%	15.4%	33.3%
Stats	90.9%	81.8%	100.0%			

Data on Teacher and Student Perceptions

Qualitative and categorical data was collected to examine teacher and student perceptions of interactions in the flipped classroom and the flipped classroom in general. This data will address the following two research questions:

3. What are student perceptions about feedback in the flipped classroom compared to feedback in the traditional classroom?

4. What are teacher perceptions about feedback in the flipped classroom compared to feedback in the traditional classroom.

Student perceptions. Students in POE 1, POE 2, and AP Statistics were given a optional, anonymous survey to complete. The survey questions are provided in Appendix F and responses to the open-ended question are provided in Appendix N. Of the 43 students partcipating in research, 31 students completed the survey. Students were asked which classroom model they preferred and why. As depicted in Figure 2 below, 48% of students preferred traditional teaching, citing reasons such the ability to ask the teacher questions during class, finding it easier to learn and take notes in class, preferring to get help with application problems outside of class, and the stress of being graded on video lessons (both teachers studied use Edpuzzle to deliver videos with integrated formative questions, though only the researcher grades these video lessons on accuracy). Two students indicated that they felt like the flipped classroom made them learn the material on their own. Of those students preferring traditional learning, two students did note that flipped lessons save time in class.
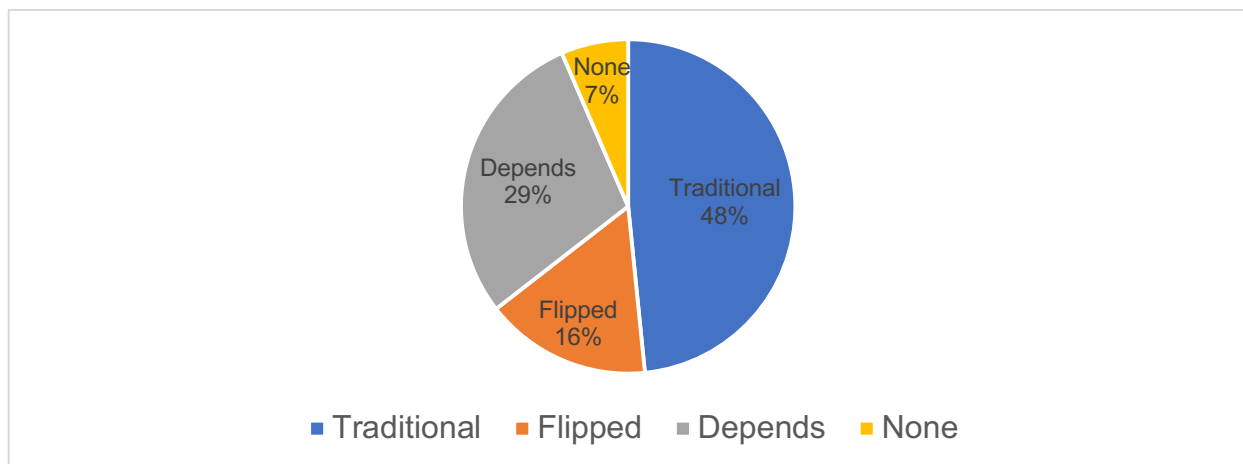
Figure 2. Student classroom model preference (n = 31).

Those that preferred the flipped classroom noted that they liked the self-paced learning and students can do more application problems in class. Students also felt they get better quality feedback in class. As one student noted:

> [The flipped classroom] allows students to receive more in-depth help during the school day and I think it's great. Doing what would have been homework during class supports the student by letting the student ask for help for harder work (if that makes sense). Of course there will be students that won't listen to/watch the lesson, but this is also true about homework in the traditional setting. This is the biggest downside of the flipped model because, if a student doesn't watch the lesson, they won't know what the next class will be about and this hinders everyone in the class from properly learning the necessary material. But for the people that do watch the lessons at home, the flipped model is very beneficial and aids in understanding the unit, and as I've found during your study, I make better grades using the flipped model, so that's always a plus.

The most common positive comment about the flipped classroom was the ability to rewatch the video lectures. In his interview, 10th grader Rory said,

> So, when we were doing programming, I really wanted to learn programming and so I watched those Edpuzzles over and over again because I wanted to make sure I understood that, and that's not something you can really do with a traditional lecture cause, like, you can't turn back time and watch it over again.

Student interview questions and transcripts are provided in Appendices G-J. During filming, two of the participants from POE 2 were talking during Unit 2, which was taught using the traditional model. One participant, a 10th grade male, talks about how much he

dislikes the activities in this unit because they are boring, and he always forgets to finish

his work for homework. His teammate, a 10th grade female, says that she misses when

the class was building robots, which was a unit where the lessons were flipped.

A substantial number of students indicated that their preference depends on the

lesson, mainly due to the difficulty of the lesson. Some of these students see the

benefits of the flipped classroom for its better use of class time and students' ability to

work at their own pace, but, like the students that prefer traditional, these students also

like to be able to ask the teacher questions and hear the teacher's explanation during

class. The issue of graded Edpuzzles was also mentioned by this group of students.

One student mentioned that his or her preference depends on the class size. The two

students with no preference did not indicate a reason for their answer.

Table 12

Five-point Likert-type Survey Questions

1. I find it easier to ask the teacher questions in the flipped classroom.
2. In a flipped setting, the teacher is more likely to address my questions than the same teacher in a traditional setting.
3. The interactions I have with the teacher in a flipped classroom are more helpful than the interactions I have with a teacher in a traditional classroom.
4. The teacher spends more time helping me in the flipped classroom.
5. I find it easier to ask other students questions in the flipped classroom.
6. In a flipped setting, students are more likely to answer my questions than the students in a traditional setting.
7. The interactions I have with other students in a flipped classroom are more helpful than the interactions I have with other students in a traditional classroom.
8. Students spend more time helping me in a flipped classroom.
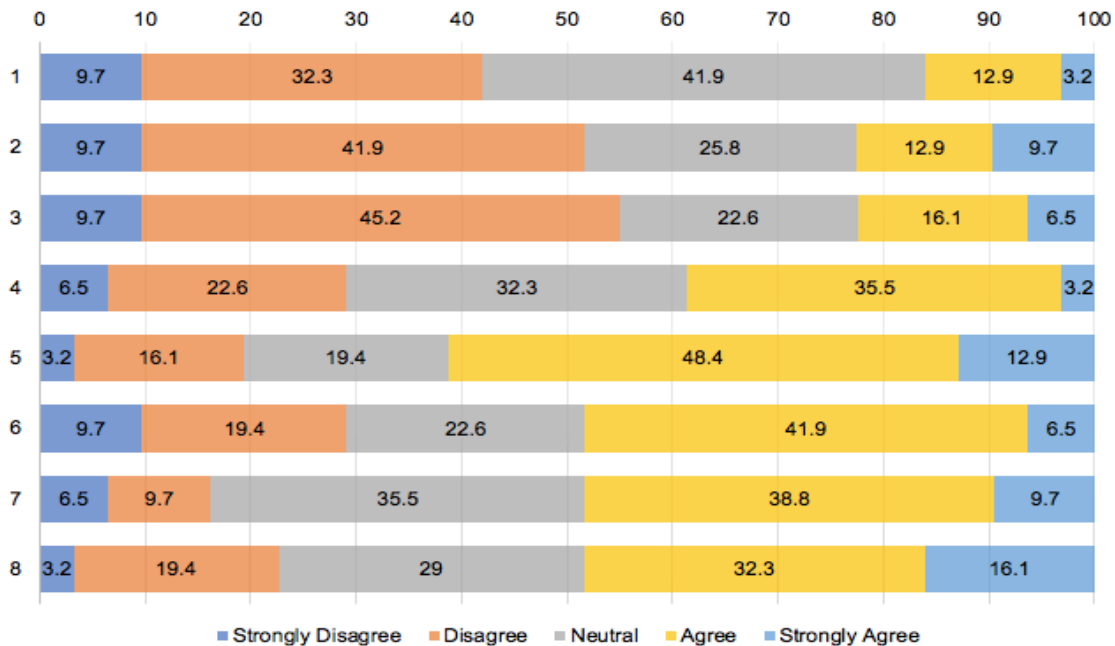
Figure 3. Relative frequency of participant responses to questions 1-8 presented in Table 12.

On the same survey, students were asked eight Likert-type questions and asked to respond with strongly disagree, disagree, neutral, agree, or strongly agree for each of the eight statements, given above in Table 12. Results of these questions are presented in Figure 3 above.

The first four Likert-type questions addressed teacher-student interactions in the flipped classroom. The students most often answered disagree or neutral to these statements, indicating negative or neutral perceptions of teacher-student interactions in the flipped classroom. In qualitative data gathered from the survey, several students indicated that there were more teacher-student interactions in the traditional classroom than in the flipped classroom.

The last four Likert-type questions addressed student-student interactions in the flipped classroom. Over 48% of students answered agree or strongly agree to these

four questions, and over 70% answered neutral, agree, or strongly agree, indicating

positive or at least neutral perceptions of student-student interactions in the flipped

classroom. In qualitative data gathered from the survey and student interviews, both

students and teachers noted that student-student interactions seemed to increase in the

flipped class. Students said that sometimes the answers they get from a student explain

the problem in an easier-to-understand way. The teacher, when asked a question in the

flipped setting, may also direct students to interact instead of relying on the teacher. The

researcher was able to encourage student-student interactions in her own flipped

classroom and observed this redirection happening in the AP Statistics class.

Teacher perceptions. Teacher perceptions were studied via a teacher interview,

available in Appendices K-L, and the researcher's own experience with the flipped

classroom. The AP Statistics teacher, Mrs. Hiddleston, who allowed the researcher to

study her class, also agreed to be interviewed about interactions and teacher

perceptions of the flipped classroom. Mrs. Hiddleston noted that the flipped classroom

increases both the quantity and quality of feedback. She noted the following:

> [W]ith the flipped classroom, we get right into the application. And so, it gives me
>
> a lot more time to sit with a table and listen to what they're doing, and decide,
>
> "Oh, wait. Stop right here. Before you can do this, you need to do this."

She mentioned several times that feedback happens in the classroom during application

problems. She said, "[T]he feedback really doesn't come until we get into something,"

referring to the applications planned for the day after a flipped video homework. Mrs.

Hiddleston remarked that the flipped classroom activities give the students a chance to

discuss the work while she facilitates the learning by listening in on conversations and

interjecting when necessary. She also said that spending more time on applications allows students to become comfortable with the processes in statistics, making them better able to give feedback to each other. Another benefit of the flipped classroom model using Edpuzzle (or similar delivery methods) that Mrs. Hiddleston mentioned is that the videos incorporate formative assessment questions and the ability to give feedback to students while they learn at home.

Concerning the flipped classroom model in general, Mrs. Hiddleston said that instruction takes longer in class than on videos, which the researcher also noticed during the study. In POE, a traditional lesson on centroids took nearly the entire 95-minute class block, when that same lesson lasts 10-15 minutes on video. Also, the units taught to POE in the traditional format took a few days longer to complete than the units taught using the flipped model. Mrs. Hiddleston mentioned two difficulties with the flipped classroom. The first was the delay between the lesson and the classroom applications. Students often forget what they learned or about what they have questions between watching the video and coming to class. She said that students pretty quickly remember their difficulties, or those difficulties become clear, once they get into the applications, though. Mrs. Hiddleston also noted that student accountability is an issue. Students may not watch the video lesson, or watch it inattentively, causing them to be unprepared for class. The researcher has had the same difficulty and noted several times when students came to class without watching the video lesson. Students are also aware of this problem and mention it a few times in the survey and during interviews. One student interviewed said, "The only time I've had bad flipped classroom experiences is when I just didn't do the Edpuzzle, and I showed up, and I was like, 'I

don't know what I'm doing.'" However, as student participants noted, and the researcher observed, students will have this problem with any homework assignment whether the assignment is a video lesson or application problems. When observing Mrs. Hiddleston's class, the researcher noticed her use of mini-lessons, delivered to the class as they were needed. Mrs. Hiddleston would stop the class when she noticed a common error that needed to be addressed or to clarify a concept that was particularly difficult. Overall, there are some key areas where teacher and student perceptions intersect, but there are some interesting differences that should be explored.

CHAPTER 5: DISCUSSION

Much of the literature on the flipped classroom indicates that students and/or teachers perceive an increase in interactions in the flipped classroom, though these interactions were only measured in one case (Baker, 2000; Fulton, 2012; Gough et al., 2017; Jeong et al., 2016; Johnson & Renner, 2012; Kostaris et al., 2017; Lage et al., 2000; Ojennus, 2015; Yanjie & Manu, 2017). One goal of this research was to determine quantitatively whether students received more feedback in the flipped classroom or in the traditional classroom. Students in two sections of the researcher's Principles of Engineering (POE 1 and POE 2) class and one section of another teacher's AP Statistics class were video recorded in small groups, and these videos were reviewed to measure the number and time of feedback interactions. This research study focused on the POE classes, and AP Statistics was used to determine how feedback interactions in the researcher's classes compare to other STEM classes that use a flipped classroom model. Feedback interactions were separated into interactions between the teacher and the student, among students, and the sum of the two. For the purposes of this study, feedback was defined as information provided to a student by a teacher or a peer that is meant to help the student get closer to the learning goal.

Teacher-Student Interactions

1. Does the increased time for teacher-student interactions provided by the flipped classroom model increase the amount of feedback teachers give to students in the classroom compared to the traditional model?

H_0: There is no statistically significant difference between the amount of feedback teachers provide to students in the flipped classroom and feedback provided by teachers to students in the traditional classroom.

3. What are student perceptions about feedback in the flipped classroom compared to feedback in the traditional classroom?

4. What are teacher perceptions about feedback in the flipped classroom compared to feedback in the traditional classroom?

To address research question one, quantitative data was collected on the number and length of teacher-student feedback interactions in the flipped classroom. Then data from a student survey, student interviews, a teacher interview and the researcher's personal observations was used, in conjunction with results from the literature, to contextualize results from this study and address research questions three and four.

Data on teacher-student feedback interactions gave mixed results. In POE 1, while not statistically significant using $p < .05$, the average number of teacher-student feedback interactions was higher in the traditional classroom than the flipped classroom, with $p < .14$. For POE 2, however, the average number and average time spent in teacher-student feedback interactions was significantly higher in the flipped classroom,

with p < .01. According to these results, we must accept the null hypothesis for POE 1, but we can reject the null hypothesis for POE 2. These contradictory results warranted further study.

Teachers and students also seem to perceive interactions that occur during traditional instruction differently. Student perceptions of teacher feedback showed that students felt they had more interactions with the teacher in the traditional classroom, while teacher perceptions indicated that they had more interactions with students in the flipped classroom. On the student survey, many students said they preferred the traditional model because they are able to ask the teacher questions about the lesson and hear the teacher explain a problem step-by-step during class. And on the Likert-type questions, over 50% of students disagreed with or were neutral to statements about teacher-student feedback such as, "The interactions I have with the teacher in a flipped classroom are more helpful than the interactions I have with a teacher in a traditional classroom." However, in her interview, Mrs. Hiddleston said that feedback happens when the students get into the applications, and that both the quantity and quality of feedback increases in the flipped classroom. Before this study, the researcher also felt there were more teacher-student feedback interactions in the flipped classroom. It is possible that teachers perceive feedback interactions in the traditional classroom as feedback provided to the whole class, while students may perceive that same feedback more personally.

These results contradict much of the literature. Several research studies noted that the flipped classroom provided more time for teacher-student interactions, some according to teacher perspectives (Baker, 2000; Gilboy et al., 2015; Gough et al., 2017;

Kostaris et al., 2017; Lage et al., 2000; Ojennus, 2015), and some according to student perceptions (Baker, 2000; Fulton, 2012; Gullayanon, 2014; Yanjie & Manu, 2017). In fact, 100% of students said they got better individual attention from the instructor in the flipped classroom in a higher education study by Gullayanon (2014). Two studies conducted in a K-12 setting also contradicted student perceptions from this study. Yanjie and Manu (2017), reported that students in the flipped classroom found the help they received from teachers and peers the most important aspect of the model. Students in a study by Fulton (2012) indicated that they liked that the teacher was available to help during class. In most of these studies, though, the authors' definition of traditional instruction was lecture and did not consider other types of traditional instruction, such as direct and dialogic instruction, that can be more interactive. Two of these studies described traditional instruction that was part lecture, part application, but student perspectives on student-student interactions were not reported (Gilboy et al., 2015; Kostaris et al., 2017).

Because of the seemingly contradictory results produced in the data and in the literature, the researcher considered whether there was a difference in the two instructional units covered during the research. POE 1 was taught Unit 1 using the traditional method while POE 2 was taught Unit 1 using the flipped method. For Unit 2 the methods were swapped, with POE 1 getting flipped instruction and POE 2 getting traditional instruction. Regardless of the method of instruction, the average number and time of teacher-student feedback interactions in Unit 1 was statistically significantly higher than teacher-student feedback interactions in Unit 2. The tasks and instruction were different in these units and could have contributed to the disparity in the data.

Unit 1 was math-heavy and traditional instruction looked more like direct instruction. Student tasks included calculating the location of centroids, finding the magnitude and direction of force vectors, and solving for the moments and forces applied to a truss. Unit 2 was less math-heavy, with tasks that included researching information about recycling, learning about material properties, and distinguishing between different manufacturing processes. Traditional instruction during this unit looked more like lecture. During traditional instruction with POE 1 in Unit 1, students were often given a chance to try problems during instruction and receive feedback from the instructor, but the flipped unit for POE 1 was Unit 2, where tasks typically required less feedback. The traditional unit for POE 2 was Unit 2, the lecture-based unit, while the flipped unit was Unit 1, the unit that elicited more feedback. It is possible that the amount of teacher-student feedback has as much or more to do with the tasks and type of instruction used in the classroom as it does with whether the class is flipped or not.

When compared to a very math-heavy, application-based AP Statistics, teacher-student feedback interactions also seem to indicate that the nature of the tasks might determine the amount of teacher-student feedback. The difference in the number of teacher-student feedback interactions between POE 1 and AP Statistics was significant at $p < .01$, and the difference in the time spent in teacher-student feedback interactions between POE 1 and AP Statistics and between POE 2 and AP Statistics was significant at $p < .01$, where AP Statistics numbers were higher in all cases. Also, the percentage of students receiving feedback was much higher in AP Statistics than in the POE classes. Since only one flipped lesson in AP Statistics was filmed, it is not possible to compare these results in terms of lecture-based, direct, or dialogic instruction because

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there are no traditional lessons to compare it to. However, like Unit 1 in POE, the tasks

in AP Statistics the day of filming were application-based, and students asked each

other and the teacher many questions ranging from basic knowledge to conceptual

understanding. One important difference to be considered too is the amount of time

required to check a problem. The instructor was asked to evaluate student work, and

these interactions took longer than usual because AP Statistics questions require

students to explain their work thoroughly, so the data on the time of feedback

interactions could be a little skewed.

While it seems that the nature of the tasks in AP Statistics had a positive effect

on teacher-student feedback, it is also possible that class size was a factor. There were

18 students in POE 1, 21 students in POE 2, but only 12 students present in AP

Statistics the day of filming. Because POE 2 typically had more teacher-student

feedback interactions, it doesn't seem like class size was a factor when comparing POE

1 and POE 2. However, it is possible that the small class size in AP Statistics gave the

teacher more time to work one-on-one with students. Class size was not a major

consideration in the literature reviewed, though Lage et al. (2000) did mention that an

effective flipped classroom would require lower student enrollment. This study was

conducted in a college setting, though, where classes tend to be larger than high

school. Interestingly, one student surveyed in this study mentioned that when the class

size is small, he or she preferred traditional learning over flipped learning, though this

student did not indicate why. When it comes to class size, if the student-to-teacher ratio

is reduced, it stands to reason that there would be more teacher-student interactions

per student whether the class is traditional or flipped.

Student-Student Interactions

2. Does the increased time for student-student interactions provided by the flipped classroom model increase the amount of feedback students give to each other in the classroom compared to the traditional model?

H_0: There is no statistically significant difference between the amount of feedback students provide to other students in the flipped classroom and feedback provided by students to other students in the traditional classroom.

3. What are student perceptions about feedback in the flipped classroom compared to feedback in the traditional classroom?

4. What are teacher perceptions about feedback in the flipped classroom compared to feedback in the traditional classroom?

To address research question two, quantitative data was collected on the number and length of student-student feedback interactions in the flipped classroom. As with research question one, qualitative data and results form the literature were used to contextualize results from this study and address research questions three and four.

The quantitative data on student-student feedback interactions was also inconclusive. In POE 1, the difference in the number of and time spent in student-student feedback interactions between the flipped and traditional classroom was not statistically significant, though student-student interactions were higher in the flipped classroom. In POE 2, the number of and time spent in student-student feedback interactions was higher in the flipped classroom over the traditional classroom, but the difference was only statistically significant when students who were absent for one day

of filming were not removed from the data. Thus, we must accept the null hypothesis for both POE 1 and POE 2. Again, because of the discrepancy in the results, the researcher considered the possibility of differences in instruction during the units. When Unit 1 was compared to Unit 2, the difference in student-student feedback was not statistically significant. Also, when results from AP Statistics were compared to results from the flipped units of POE 1 and POE 2, there was no statistically significant difference in the number or time of student-student feedback interactions. Thus, the amount of student-student feedback seems to have less to do with the nature of the tasks or the type of instruction replaced by flipped instruction in each unit and more to do with whether the instruction is flipped or traditional. While the quantitative results do not definitely dictate that the flipped classroom increases student-student feedback interactions, these results do seem to imply that the flipped classroom is at least partially effective in increasing student-student feedback interactions. The literature on the flipped classroom agrees that student-student interactions increased in the flipped classroom (Baker, 2000; Jeong et al., 2016; Kostaris et al., 2017; Johnson & Renner, 2012; Yanjie & Manu, 2017), though only one study measured these interactions. Johnson and Renner (2012) observed student-student interactions in their K-12 study and counted eighteen student-student interactions in the flipped classroom but only eight in the traditional classroom.

Student perceptions of student-student interactions also agreed that they increased in the flipped classroom. As Jack said in his interview,

Interactions with students would be more likely [in the flipped classroom] just because they are already there, and they have done the same Edpuzzle that you

did, so it's easier. If they understand they can explain it to you, and you're

working together so it's like, if somebody understands one part, they explain it to

you and if you understand the other part, then you can explain it to them. So, it's

kind of like mutual teaching, I guess.

On the student survey, students were more positive when responding to the Likert-type

questions about student-student interactions in the flipped classroom than about

teacher-student interactions in the flipped classroom, with over 48% agreeing to

statements like "The interactions I have with other students in a flipped classroom are

more helpful than the interactions I have with other students in a traditional classroom."

However, on the open-answer question on the survey, while many students discussed

teacher interactions, no student mentioned collaboration or student-student interactions.

Collaboration is an important aspect of both the researcher's and the AP Statistics

teacher's courses no matter what model of instruction is used, so it is possible that

students do not see collaboration as unique to the flipped classroom model.

While student-student interaction is important in the classroom, both teacher and

student responses indicated some difficulties. Mrs. Hiddleston noted the following when

asked if students can provide feedback to each other:

[T]he whole entire second semester is inference. And so those processes

become a lot the same from unit to unit, maybe with different formulas, so once

[the students have] gotten comfortable with inference, they can. They can start to

give each other feedback like, "Wait. No, you can't write it that way because this

is a proportion, or these are means." But not immediately, no. They all have to

learn the process initially, which is why that initial, right after the video, coming in

and really learning the process is so valuable and why we need so much more

class time to get that done.

Mrs. Hiddleston mentioned earlier in her interview that the flipped classroom frees up

class time for students to learn these processes, but her response indicates that

students might not be the most reliable sources of feedback until they are comfortable

with the material. From student survey and interview responses, it seems that students

tend to trust teacher answers more, but value student feedback because students can

explain concepts in a different and/or easier-to-understand way. As a student quoted in

Lage, "The groups were very effective – it helped to have your peers explain things to

you in a different way that sometimes made more sense" (2000, p. 35). However,

students might not depend on their classmates to be accurate. As Amy said in her

interview, "It really depends on which student you ask."

While watching videos, the researcher noticed that some students rely heavily on

teacher feedback while others rely heavily on student feedback. A few students

mentioned to other students in their group that they were hesitant to ask questions of

the teacher during class for fear of "looking stupid." Often other students would

encourage the hesitant student to ask, but in none of these observed cases did the

student ever ask the question. Other students would only ask the teacher for help, and

rarely if ever accepted feedback from students. And there were a few students that

seldom spoke to anyone. Students in Heng Ngee's study (2014) preferred the flipped

classroom, and student perceptions were generally positive, but the students that did

complain were those that had difficulty with their partners. Several factors, such as

personality or group structure, can influence interactions in the class, especially student-student interactions.

The researcher noticed a few times during videos where the instructor influenced student interactions in both good and bad ways. Instructors occasionally directed students to work with each other to solve a problem instead of relying on the teacher. This redirection indicates the importance both teachers in this study place on student-student communication in the classroom. Another phenomenon the researcher noticed while watching flipped classroom videos was how teacher feedback can derail good student interactions. During her own class, the researcher was moving around the room, checking student progress. One group had moved past a problem that they had worked incorrectly but was having a good conversation about the problem they were currently working. The instructor attempted to call attention to the error without interrupting the students' momentum. She quickly told the group to finish the problem they were working on and then reconsider the previous problem with the error, but after she left, that group went immediately to the problem with the error and lost track of the good conversation they were having.

Other Student and Teacher Perceptions

Several interesting themes occurred in the data that did not directly relate to feedback in the classroom. Those themes are explored here.

Students' instructional preference. Many of the studies reviewed reported student perceptions of the flipped classroom, which were generally positive (Bishop & Verleger, 2013; Blair et al., 2015; Day & Foley, 2006; Fulton, 2012; Fowler, 2014; Gannod et al., 2008; Gilboy et al., 2015; Gullayanon, 2014; Heng Ngee, 2014; Jeong et

al., 2016; Kerr, 2015; Kostaris et al., 2017; Lage et al., 2000; Mason et al., 2013; Meyers, 2016; Ojennus, 2015; Roach, 2014; Sowa & Thorsen, 2015; Yanjie & Manu, 2017). However, 48% of students surveyed in this research preferred the traditional classroom and another 29% indicated that their preference depends on the lesson. Only 16% preferred the flipped classroom. Several factors could be at play. The main reason students cite for preferring the traditional classroom is that they cannot ask the teacher questions during a flipped lesson, a difficulty students in Gilboy's (2015) study also shared. Since the traditional classroom in many of the referenced studies is lecture-based, students in those studies might not have the opportunity to ask questions of the teacher during class. Students in this study, however, may be more accustomed to direct or dialogic instruction and have more opportunities to communicate with the teacher during the lesson. In fact, the Likert-type questions from the student survey indicated that students did not feel like they had more interactions with the teacher during the flipped classroom.

Another possibility is that students prefer traditional instruction simply because it is easier or more familiar. As Gullayanon said, "Attitude is another barrier to the implementation of the flipped classroom in Thailand. A large number of students are still raised to listen and memorize information given to them rather than ask questions and seek explanations themselves" (2014, p. 12). That attitude is not unique to Thailand. In the survey, students made comments such as, "It is the teachers' job to teach. Teachers get paid to educate their students during school hours, not to send home educational videos to do out of school hours," and "I can't usually understand the material if I have to teach it to myself." Students sometimes prefer to be passive consumers of

knowledge, but the flipped classroom requires students to be actively engaged in their own learning. Carlisle (2010) found that the less the professor lectured, the more students prepared for class. Fowler (2014) said that it was important to engage with students, otherwise they would just wait for solutions to problems. In Gullayanon's study (2014), students that preferred traditional instruction said it was less stressful because they didn't have to prepare for class. Some even indicated that they could copy homework in the traditional model. In her interview, Amy noted that the flipped classroom seemed to decrease cheating. While it might frustrate some students, the flipped classroom may increase students' engagement with their own learning.

Students in this study also expressed concerns about student responsibility. Bergmann and Sams (2012) say that one of the by-products of the flipped classroom model is that students gain a sense of accountability for their own learning. Johnson and Renner (2012) disagreed, though. Students in their study did not seem to gain a sense of responsibility for learning. The students were motivated by grades, and student absences caused a problem with collaborative assignments for the flipped classroom. Students in Gilboy's (2015) study also mentioned the concern that other students would not come prepared for class. Unprepared students were a problem in this study too. Amy, who was in POE 2, indicated that the teacher was asked more questions during the flipped classroom because students in the class were not taking their learning seriously. She said,

> I feel like a lot more questions were presented to the teacher because a lot of the
> time [students] would watch the Edpuzzles haphazardly. I noticed that a lot
> amongst my peers. And they would have a lot of questions. … [W]hen we were

learning vectors and the senses, a lot of them didn't know what a sense was

because they didn't really pay attention to the provided Edpuzzles.

Knowing the sense of a vector is basic knowledge for that unit, so while students asked

more questions, and the data shows an increase in teacher-student feedback for this

class's flipped lessons, it is possible that feedback was not for higher-order questions.

Concerning teacher-student interactions in the flipped classroom, Jack, also in POE 2

said, "I think interactions between me and the teacher are less likely just because the

activities are more independent or with your group, so whenever we do flipped

classrooms, you're more likely to get help from students than teachers." Despite the fact

that teacher-student interactions were higher in the flipped model for his class, Jack still

perceived that there were less teacher-student interactions and more student-student

interactions. This discrepancy could be because he personally didn't need as much

teacher feedback. He typically takes his studies very seriously and may not have

noticed his classmates asking questions.

Student accountability was a problem from the teachers' perspectives too. Mrs.

Hiddleston said that her biggest challenge with the flipped classroom is holding the

students accountable for their learning. The researcher also noted several times that

students would come to class without having watched the video lesson. However, this

was also true of homework assignments. As one student pointed out on the survey, "Of

course, there will be students that won't listen to/watch the lesson, but this is also true

about homework in the traditional setting. This is the biggest downside of the flipped

model because, if a student doesn't watch the lesson, they won't know what the next

class will be about, and this hinders everyone in the class from properly learning the necessary material."

Positives of flipped instruction. Those students that preferred the flipped classroom, and a few whose preference depends on the lesson, wrote that they liked self-paced learning and doing applications in class. In the literature, students often agreed that these were positive of the flipped classroom (Bishop & Vergleger, 2013; Blair et al., 2015; Fulton, 2012; Gilboy, 2015; Lage et al., 2000; Mason et al., 2013; Ojennus, 2015; Yanjie & Manu, 2017). The researcher also found the flipped classroom much more interesting to teach, a sentiment with which the instructors in a study by Lage et al. (2000) agreed.

Two that indicated a preference for traditional learning acknowledged that the flipped classroom is a better use of class time. One said, "I like being able to ask questions, but I still understand learning at home since there is not enough time in class." The instructors in this study agree that moving lectures to video lessons frees up class time for more engaging instruction. And in the POE classes, the researcher noted that teaching the same unit using traditional instruction took more class days than flipped instruction. The literature also agrees here. Mason et al. (2013) found that the instructor was able to cover more content during the flipped classroom and students felt the model was a better use of class time, and students in Heng Ngee's (2014) study recognized that the videos allowed for more time in class.

Potential issues with the flipped classroom. During flipped instruction, the researcher noticed that students left their group to seek help from another group. This freedom of movement and communication around the classroom was not obvious in the

traditional classroom model. While the researcher did not mind, and often encouraged, this movement, some teachers might find it causes distractions in the classroom. Bergman and Sams (2012) said the flipped classroom will improve discipline issues, but the research did not agree. In a K-12 study by Fulton (2012), teachers that use the flipped classroom said that classroom management was challenging because the dynamic of the room had changed. Gough et al. (2017) also studied K-12 teacher perceptions, and those teachers indicated that discipline issues did not decrease in the flipped classroom. The flipped K-12 classroom may necessitate a change in management style for teachers.

Interestingly, access to technology was a concern for teachers, students, and parents in several K-12 studies (Bergman and Sams, 2012; Fulton, 2012; Gough et al., 2017), but no students mentioned technology difficulties in this study. The high school in this study provided students with a laptop, and the school opens and buses arrive 55 minutes before first block to give students an opportunity to work on assignments, make up missing work, or seek help from teachers and peers before the day begins. These accommodations may have alleviated some of the technology difficulties students have in other schools.

Video lessons with formative assessment. Some of the literature mentioned using formative assessment with video lectures to guide instruction and/or monitor student progress, but these assessments have not been directly studied (Gilboy et al., 2015; Gullayanon, 2014; Heng Ngee, 2014; Jeong et al., 2016; Ojennus, 2015; Sowa & Thorsen, 2015). As Rory said in his interview, "[I]t's also nice to have a lecture integrated with questions, which you can do with a normal lecture, but it's nice to have

questions on what you had, and if you need to, you can rewind two minutes back and learn that specific information again. And then answer a question on it." Two studies mentioned student perceptions of these formative assessments, and both seem to agree with Rory that the formative assessment helped them understand difficult concepts or know where they were struggling (Heng Ngee, 2014; Jeong et al., 2016).

Both Mrs. Hiddleston and the researcher use the formative assessment capabilities of Edpuzzle in their video lessons, thus making the lessons a more interactive experience. Rory said that Edpuzzles are "kind of interactive." This feature could explain the decreased teacher-student feedback during the flipped lessons. Some of the teacher-student interactions that would normally happen in the classroom are happening at home in this flipped classroom model. Johnson and Renner (2012) also observed something similar. Students in their study asked more questions of the teacher during the traditional classroom than the flipped classroom. The authors conjecture that students may have been asking each other more questions during the flipped classroom, but those questions were not observed. They also conjecture that students' questions may have been answered during the video tutorials.

Scope and Limitations

This study has several delimitations that must be considered. The sample chosen and structure of the study could limit the generalizability of the results. This study was conducted in engineering classes in a high school setting in suburban Mississippi, and the results of this study may only apply to that sample or a sample with similar characteristics. The study did not include high school freshman, so results could differ if that population were included. Also, this study had a small number of

participants, so the results may not be applicable to a larger population. While the goal was to study the flipped STEM classroom, only math and engineering classes that are not taken by the general high school population were considered. Finally, these results may only apply in classes that use similar tasks and instructional strategies.

While video recording small groups allowed the researcher to observe more interactions than would be possible by just observing in class, some interactions may have been missed or misinterpreted, causing limitations in the results. Some students were quiet or may not have been visible in the video, and other noises occasionally blocked the video sound, so it was sometimes difficult to hear or understand the interaction happening. In those cases, the interaction was not counted as feedback. In POE2, there were several students that chose not to participate in this research, and sometimes those students seemed to get more or less feedback than the average for that day, so their data could have changed the results if it had been collected.

Future Research

Several aspects of the flipped high school STEM classroom should continue to be explored. One major question that emerged from this research is how the classroom tasks or type of instruction affect the feedback delivered in the flipped classroom. When observing traditional instruction, there seems to be a difference in feedback during lecture versus during direct instruction. Another consideration is to expand the work of Yanjie and Manu (2017) and further study the impact of dialogic instruction when it is used instead of or in conjunction with flipped instruction.

This study only measured the feedback students receive in the classroom, but an interesting question is how the feedback available via technology at home influences

feedback in the classroom. This study also did not focus on student accountability in the flipped classroom, though students and teachers noted its importance to the model. While some studies have considered student accountability, it has not been thoroughly studied in the K-12 setting. Another expansion of this research could be to look carefully at peer interactions and feedback, paying attention to the quality of feedback and discourse among students in the flipped versus traditional classroom.

Two themes this study did not explore at all were student performance and women and minorities in the flipped classroom. There are few studies on the flipped classroom in the K-12 setting in general, and data on student performance in the flipped K-12 classroom is thin and inconclusive. The researcher found no K-12 studies that reported on women and minorities in the flipped classroom. There is much room for more research in this area.

Conclusion

While the data is inconclusive, there is some evidence that the flipped classroom may increase student-student feedback interactions. While students in this study seemed to prefer traditional instruction or a balance of traditional and flipped, the instructors and many students agree that student-student interactions were better in the flipped classroom. Concerning teacher-student interactions, the research shows that the nature of the classroom tasks and the type of instruction used – lecture, direct, or dialogic – seem to have an influence on the amount of teacher-student feedback in the classroom. Students and teachers in this study disagreed about teacher-student feedback. Teachers felt there was more teacher-student feedback in the flipped

classroom while students felt there was less. More study is required on both student-

student and teacher-student feedback interactions to reach any definite results.

CHAPTER 6: INFORMAL ADDENDUM

Introduction & Purpose

In the original research, feedback was defined as information provided to a student by a teacher or peer that is intended to help the student get closer to the learning goal. That research focused entirely on feedback delivered during class; thus, it did not take into account feedback that might be provided at home during the flipped classroom video lecture. The continued research presented in this chapter explores feedback interactions provided during recorded video lectures.

Edpuzzle, which allows instructors to add questions within the video lecture that students must answer before moving on in the video, is the platform used to deliver video lessons to students, though other platforms are available that work similarly. Students may re-watch portions of the video that came before the question, but they may not move on in the video until the question is answered. The questions can be multiple choice or open-answer. Multiple choice questions are automatically graded, and students are told immediately if they are right or wrong. Open-answer questions must be graded by the teacher, so feedback is dependent on when the teacher grades the work. The researcher most often uses multiple-choice questions for the immediacy of feedback. Because this feedback is delivered directly to the student based on their own work, it is individualized and, in most cases, delivered as soon as the student has completed the task, so it would fit some of the major criteria that Hattie and Yates deem

necessary for effective feedback (2014). According to Salder (2010), though, "Feedback should help the student understand more about the learning goal, more about their own achievement status in relation to that goal, and more about ways to bridge the gap between their current status and the desired status" (p. 536). While it is difficult to determine if all of these elements of feedback are being met via video lessons, it is important to attempt to research at-home feedback to fully understand the impact of the flipped classroom on student learning.

Determining if students are getting feedback from the questions in video lessons requires a slight adjustment to the original definition of feedback. Using the original definition, every question asked within the video would be a feedback interaction between teacher and student simply because letting the student know if her answer is correct is information intended to help the student get closer to the learning goal. When a teacher is providing feedback in person, however, she can use verbal or nonverbal clues from the student to determine if the information provided was heard and understood, and she can stay with a student until those clues are evident. Teachers do not get those verbal and nonverbal clues from students via Edpuzzle, so a different way to understand feedback interactions is needed. The researcher used student surveys to find out more about this at-home feedback, so student-friendly language is also important. In the surveys, students were asked about feedback by asking if the questions or examples provided in the video lesson helped them learn. Students were also asked to share what, if anything, they did before and after questions and examples. Thus, feedback is redefined as information provided to the students by a teacher or peer that helps the student learn and ideally encourages students to do extra work,

when necessary, to bridge the gap between their current understanding and the learning goal.

The goal of this continued research is to learn more about the flipped classroom's potential for increasing teacher-student feedback interactions. Because the flipped classroom model can include formative assessment with feedback, it is possible the original research undercounted teacher-student feedback interactions in this model. Another goal is to learn how the interactions are perceived by students, which may allow teachers to better leverage the flipped classroom model of instruction to enhance feedback and student learning. The following research questions will be considered:

1. Did the original research undercount the number of teacher-student feedback interactions by not counting at-home feedback?

2. How does feedback received from video lessons with questions compare to feedback received from video lessons without questions?

3. What are student perceptions about assessment and feedback within the video lessons?

Methodology

This study was conducted with second- and third-year engineering students at a suburban high school in Mississippi during the Fall semester of 2018. The researcher is also the teacher in these courses. Second-year students take a course called Principles of Engineering (POE), and third-year students take a course called Digital Electronics (DE). The researcher teaches two sections of POE and one section of DE. Students in DE are a subset of the same students studied during the 2017-2018 school year, and the demographics of both the POE and DE students are very similar to the students

involved in the original research. Both courses utilize a flipped classroom model of instruction and video lessons are delivered via Edpuzzle.com.

POE students were asked to complete one optional, anonymous survey at the end of a video lesson. DE students were asked to complete an optional, anonymous survey at the end of three different video lessons. The classes were told about the survey and the research the teacher was conducting, and each video started with a short note about the survey and ended with a link to the survey, which was delivered via Google Forms. All questions on the survey were optional.

The first survey, given to both POE and DE students, asked students to determine whether or not questions throughout the video helped them learn. The students were also asked to report anything they did before or after the survey to help them understand the question asked. A total of 31 students out of the 62 students in POE and DE responded to the survey. See Appendices O and P for the complete surveys and Appendices Q and R for the survey responses. For POE students, the six questions within the video lesson were all multiple-choice questions, and thus students knew immediately after submitting their answers whether they were correct. For DE students, three of the six questions were open-answer, but two of those questions were answered immediately in the video after the students submitted their own answer. For only one question did students have to wait on the instructor to grade the video lesson to know if their answer was correct.

The researcher wanted to compare a video lesson with questions to one without, so a second survey was administered to the DE students. The researcher only used these students after the first survey because POE had no more video lessons

scheduled during the research window. The video that corresponded with this second survey only asked students to pause the video and try problems presented in the video. The instructor worked out these problems in the video, so, after restarting the lesson, students could see if their work was correct. A total of 12 students responded to the survey. See Appendix S for the survey questions. Survey responses are provided in Appendix T.

After the second survey, the researcher was curious how the prompts to stop and try problems changed the potential for feedback in the videos, so a third survey was administered to the DE students. For the corresponding video lesson, the researcher altered the standard video format again so that the lesson was simply a recorded lecture with no prompts to pause and try problems that were worked out in the video. A total of 11 students responded to the survey. See Appendix U for the survey questions. Survey responses are provided in Appendix V.

Results

Survey 1

In the first survey, administered to both DE and POE, students were asked to indicate if each question given within the video lesson helped them learn. They were also asked to indicate what, if anything, they did before and after answering each question within the video lesson. There were six questions in each video lesson and a total of 31 students responded to the survey, 14 in POE and 17 in DE. This represents only 33% of the POE students but 89% of the DE students in these classes. Students overwhelmingly said the questions within the video lesson helped them learn, as shown

in Figure 4 below. In fact, every student indicated that at least one question helped her

learn except for one student that marked "I don't remember" for every answer.
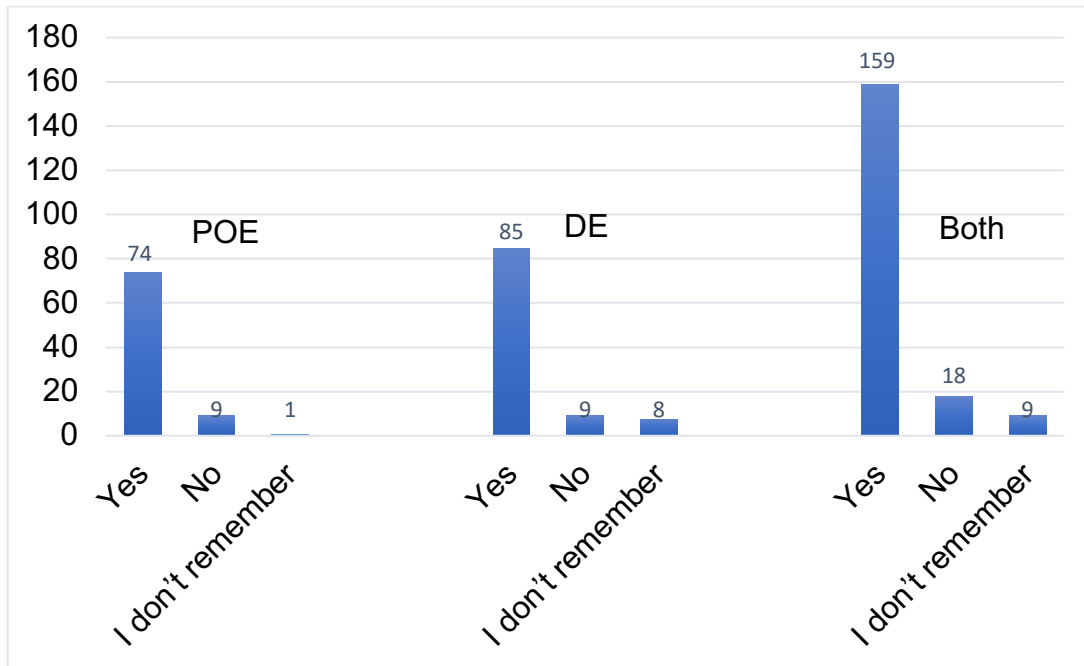
Figure 4. Frequency of participant responses to the question, "Did attempting this question and finding out whether you were correct help you learn?"

In Figures 5 and 6 below, student responses to what they did before and after

working questions within the video lesson are summarized. Students were able to

choose from a list of prepared options or write in a response under "other."
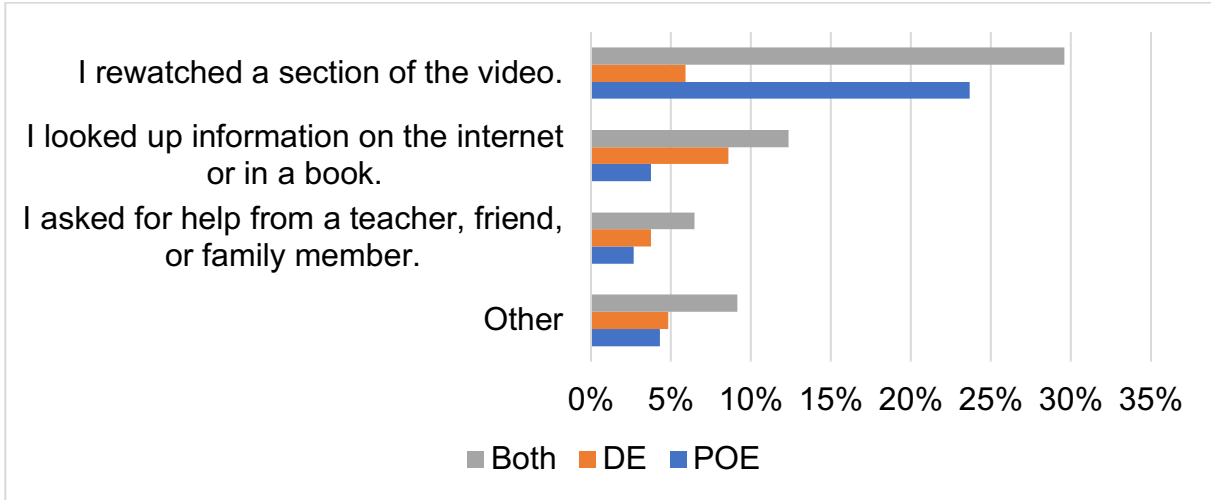
Figure 5. Percentage of participant responses to the question "Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply."
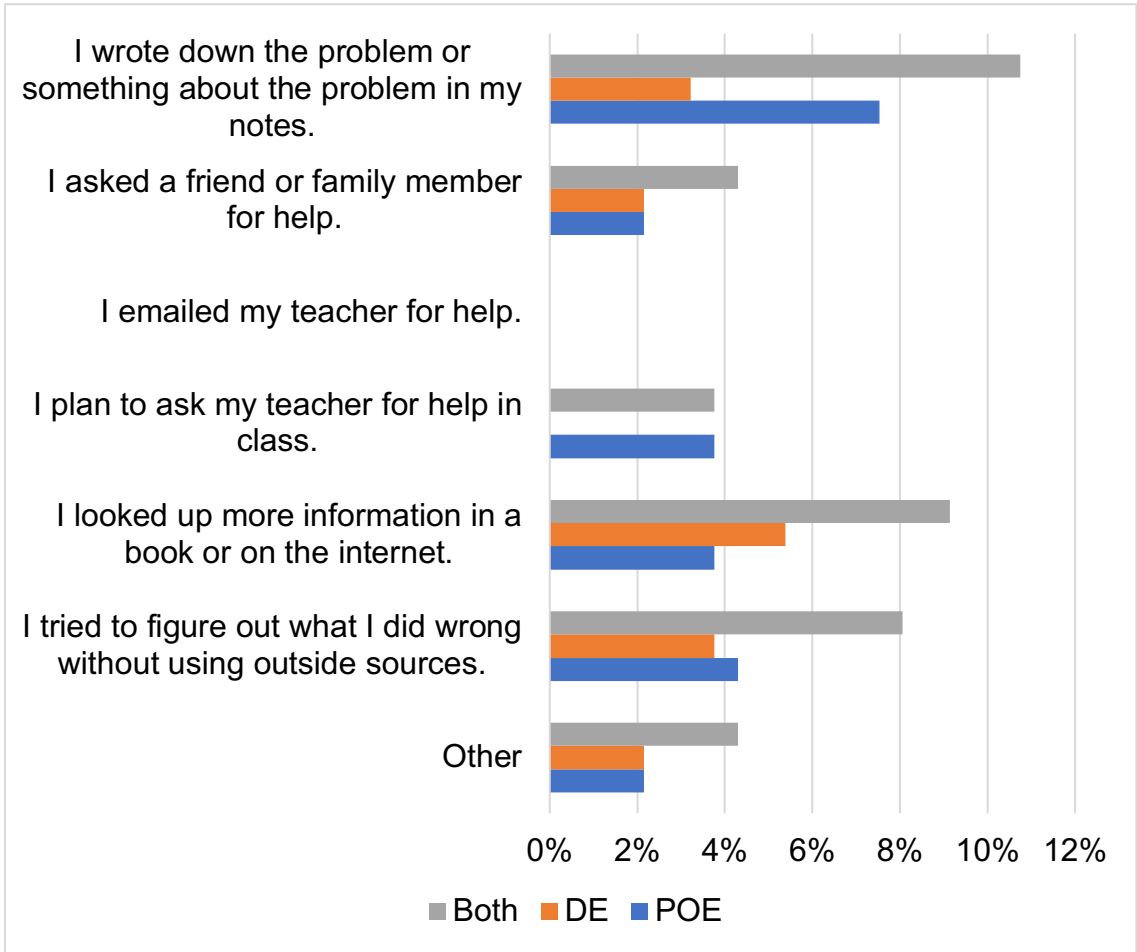
Figure 6. Percentage of participant responses to the question "Did you do anything AFTER you found out if you were correct or not? Select all that apply."

Before the students selected an answer, most students chose to re-watch a section of video. However, when comparing POE to DE, students in DE more often looked something up rather than re-watching the video. The most common write-in response under other was that students wrote down and/or looked at their notes from the video lesson. Six students specified a response related to notes. One student mentioned that she asked her teacher in person before selecting an answer, indicating that she came in before school to get help with the video lesson.

After students worked the problem, the most common action was to take notes. When comparing POE student to DE students, DE students more often looked up information or tried to figure the problem out on their own rather than taking notes. For those students that chose to write in a response, the information they provided was unclear or unenlightening. Three times a student indicated that she worked the problem, which is confusing because that should have been done before selecting an answer. One student wrote in, "I havent [sic] found out if I was correct yet because you told us to ask you in class tomorrow." This response was based on an open-ended question that was addressed in class the next day, though students could easily have searched the internet for that answer.

Survey 2

The second survey was only administered to DE students, with 12 of 19 students responding. In the video lesson corresponding to this survey, students were not required to answer questions within the video to move ahead but instead were prompted to pause the video and try problems. Those problems were completed by the instructor within the video so that students could see if they were getting the answer

correct. As shown in Figure 7 below, 50% of students indicated that they preferred a video lesson with questions and 25% indicated that they had no preference. Of those students indicating they preferred questions, most liked that questions required them to stop and practice. Of those students that indicated that they do not prefer questions within the video lesson, the most common negative was the grade associated with the questions. One student with no preference indicated that she would do the problems whether they were required or not, so she is getting the same experience both ways. These responses will be explored further in the discussion section.
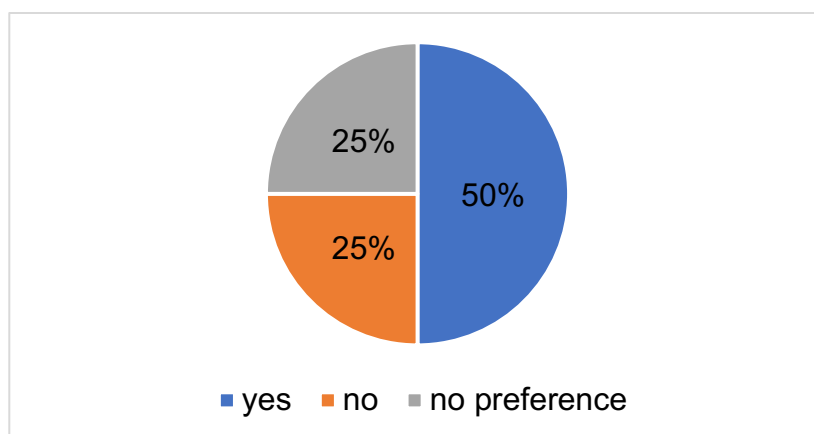
Figure 7. Student responses to the question, "Do you prefer an Edpuzzle with questions?"

Realizing that some students might not prefer a video lesson with questions but still might understand that the questions can help them learn, students were also asked to respond to a prompt about whether questions within a video lesson help them better understand the content. The responses are shown below in Figure 8. Most students find that questions within the video lesson help them learn at least sometimes. They said things such as "[f]ailure to understand a question initially causes one to rethink and redo

a problem" and "[questions in the video] make it so you have to understand the content more to answer the questions." Only one student marked that she did not prefer video lessons with questions and did not find that questions in the video lesson were helpful for learning. She said, "Because with questions I have to remember what we were just talking about and it will make me get confused easier if I were not to understand it." Other student responses will be explored further in the discussion section.
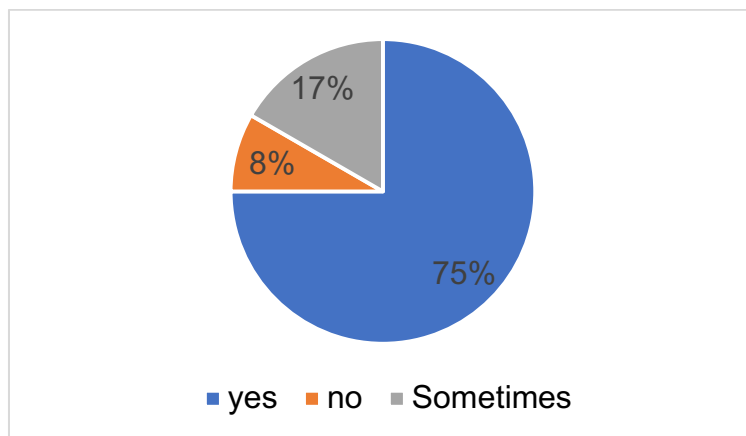
Figure 8. Student responses to the question, "Do you find that having questions within the Edpuzzle helps you better understand the content?"

Students were prompted to pause and try a problem five times within the second video lesson in this study. In the survey, students were asked about each of these opportunities to pause. As shown in Figure 9, students most often indicated that they did not pause the video, though only by a small margin.
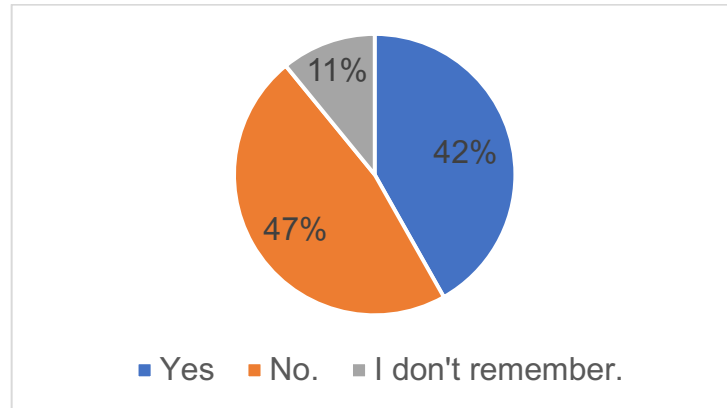
Figure 9. Frequency of participant responses to the question, "Did you pause the video to try this example?"

Students were also asked to indicate if pausing and trying an example helped them learn. Results of this question are shown below in Figure 10. Most students indicated that it was at least somewhat helpful to pause and try the problem. Interestingly, though, the number of times students indicated that pausing was helpful (29) was higher than the number of times students indicated they actually paused the video to try the problem (23). This result will be explored further in the discussion section. Because of the discrepancy in this result, the data was analyzed again after removing the two students that marked inconsistent answers. Those results are depicted in Figures 11 and 12 below.
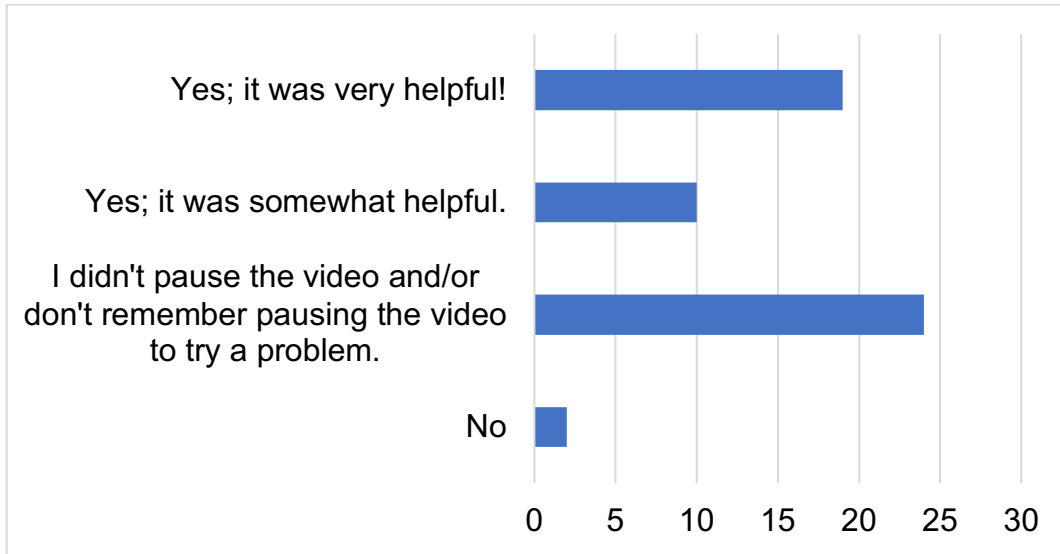
Figure 10. Frequency of participant responses to the question, "Did you feel like pausing the video and trying this example helped you learn?"
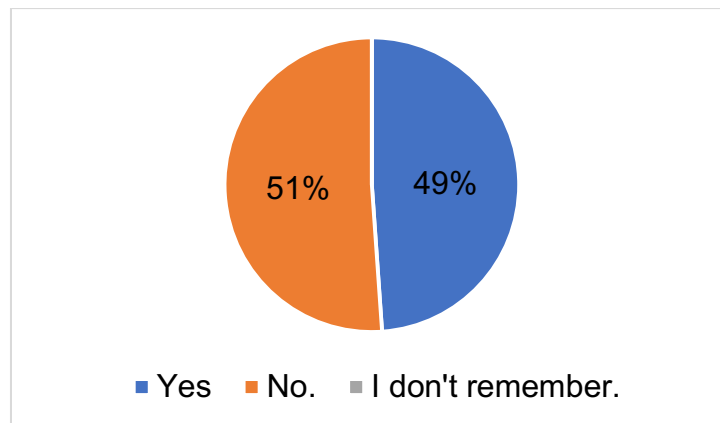
Figure 11. Frequency of participant responses to the question, "Did you pause the video to try this example?" with discrepancies removed.
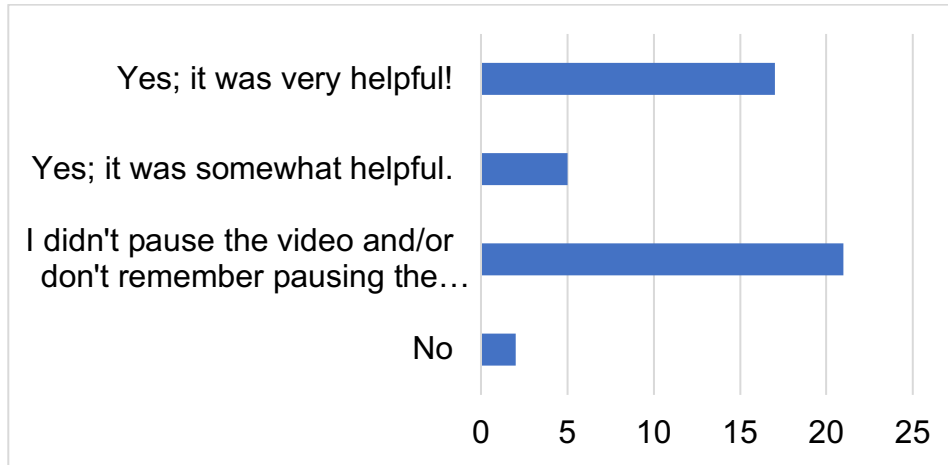
Figure 12. Frequency of participant responses to the question, "Did you feel like pausing the video and trying this example helped you learn?" with discrepancies removed.

Like the first survey, students were again asked what, if anything, they did before and/or after pausing and trying a problem. In Figures 13 and 14, below, the response "No or I don't remember" combines all students who responded that they did nothing before or after pausing the video, they didn't pause the video, or they don't remember pausing the video. These three responses were the most common by a large margin.
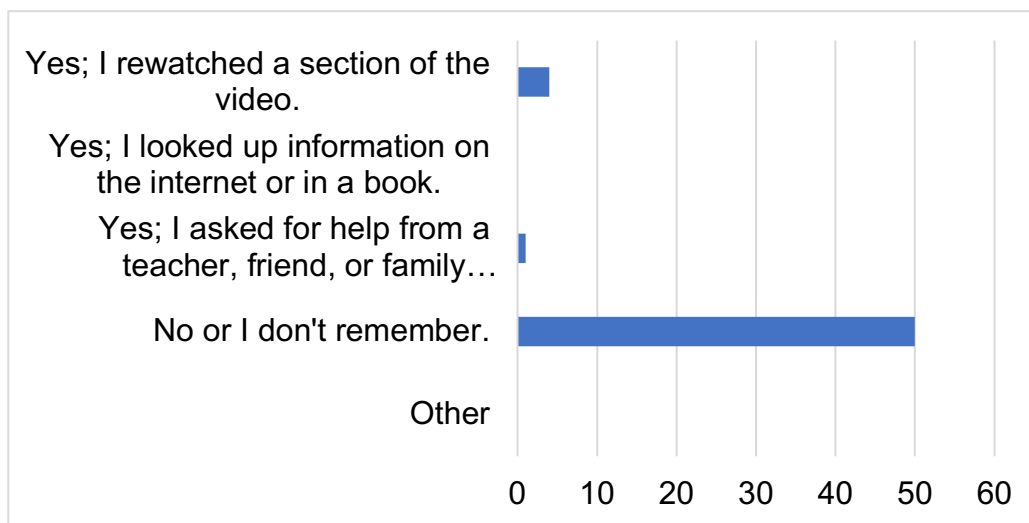
Figure 13. Frequency of participant responses to the question "Did you do anything BEFORE tried this example? Select all that apply."
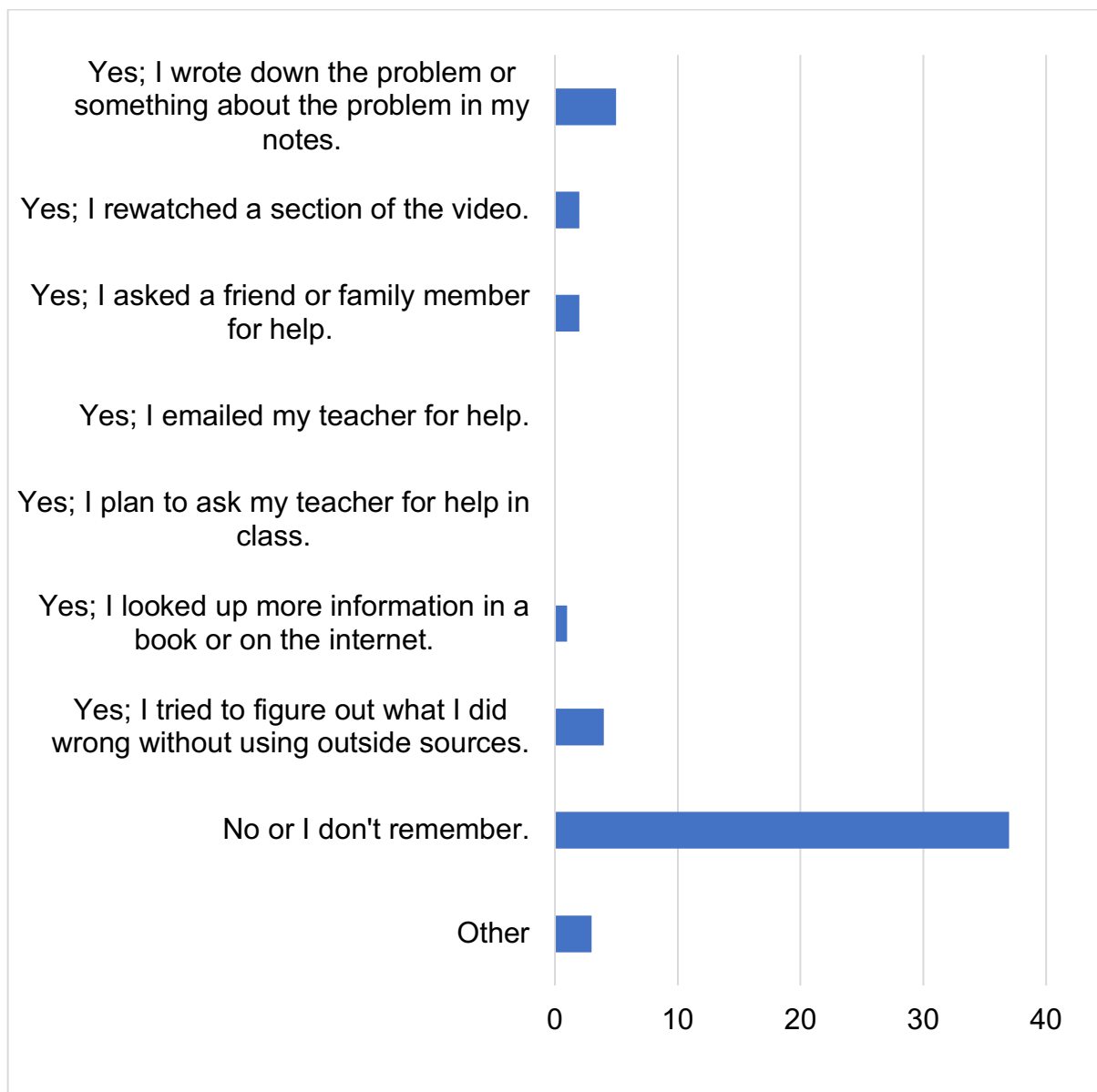
Figure 14. Frequency of participant responses to the question, "Did you do anything AFTER you found out if you were correct or not? Select all that apply."

One student's other was that she did "the part on the homework that was like this" or otherwise indicated "hw" as her "other" three times. The activity she refers to as homework was actually an in-class activity done after the video lesson, which indicates that she either missed class or was behind in the work.

Survey 3

The third survey was only administered to DE students, with 11 of 19 students responding. In the video lesson corresponding to this survey, students were not required to answer questions within the video and were not prompted to pause and try a problem. The video was simply a recording of a lecture. After the video lesson, students were asked to compare that experience to their experiences in the previous two video lessons. The first portion of the survey asked about student preference for questions within a video lesson. Results are depicted in Figure 15 below.
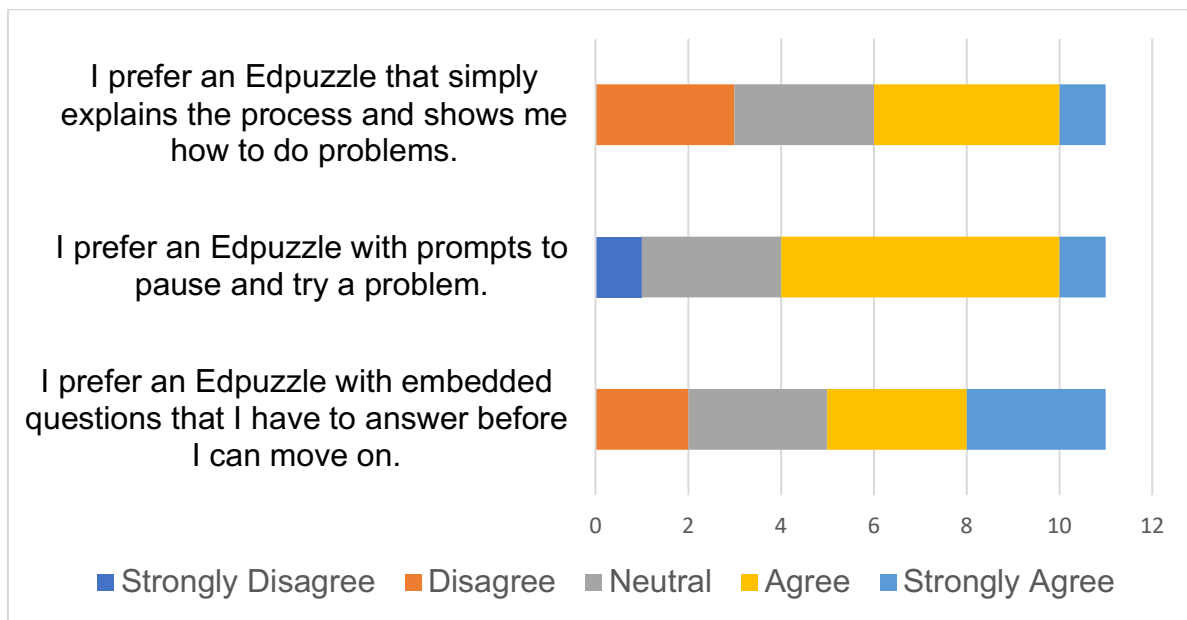
Figure 15. Frequency of student responses to various prompts about their preference regarding questions in the video lesson.

Students were given an opportunity to explain their preferences. Answers varied greatly. One student said, "[I]t gives me anxiety when there are questions i [sic] have to do and it stresses me out pls [sic]," while another said, "I like to do the problem and know whether or not I got it right so that I can fix it as soon as possible." Student comments will be explored further in the discussion section.

Again realizing that some students might not prefer a video lesson with questions but still might understand that the questions can help them learn, students were also asked to respond to prompts about their perceived learning. As shown in Figure 16 below, most students agree or strongly agree that having questions within the video lesson helps them learn.
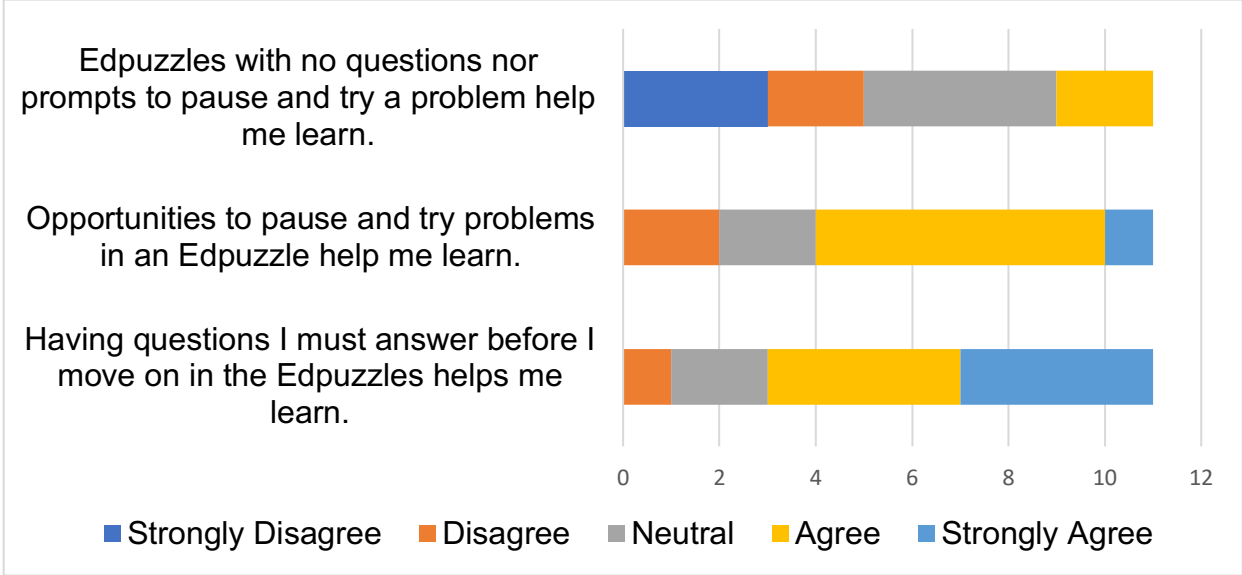
Figure 16. Frequency of student responses to various prompts about their learning from questions in the video lesson.

Discussion

RQ1: Did the original research undercount the number of teacher-student feedback interactions by not counting at-home feedback?

Results from the first survey indicate that during a video lesson with six questions students were required to answer before moving on in the lesson, students indicated that a question helped was helpful for learning 159 times. Just taking student learning as a standard for feedback, those 159 additional teacher-student feedback interactions

average to approximately five feedback interactions per student. Considering that at-home feedback should encourage students to work to bridge the gap between their current learning and the learning goal when necessary, it is also important to look at how many times students did something before and/or after questions in the video lesson. POE students did something before and/or after a problem 62 times and DE students did something before and/or after a problem 55 times. Thus, these 31 students got 117 additional teacher-student feedback interactions, or a little under four per student. During the original study, the average number of teacher-student feedback interactions during a flipped class was between 0.71 and 1.37 per student. Based on these results, by only counting in-class feedback interactions, the original research study undercounted, possibly drastically undercounted, teacher-student feedback interactions in a flipped classroom. Also, with the exception of the one student that marked "I don't remember" for every answer, all students indicated that they were able to learn from at least one question in the video lesson. Taking into careful consideration that some students may just mark answers that they think their teacher wants to see, it is still reasonable to conclude that questions within the video lessons have the potential to help students get closer to their learning goal by providing individualized, immediate feedback. Recalling that feedback has an effect size of 0.75 (Hattie et al., 2017), including questions with the video lessons is a very important element in the flipped classroom model.

One pattern in student responses that is noteworthy is that students tend to do something before more often than after answering questions within the video lesson. One interpretation of this pattern is that students are not using the feedback they get

from questions to self-reflect. Another is that students are getting feedback just from seeing and being required to answer a question. Lack of initial knowledge is encouraging them to evaluate their learning and get closer to the learning goal by re-watching sections of the video or looking up information. These questions are letting them know they need to work more. This second interpretation is reinforced by noting that in POE, every student did something before and/or after and in DE, only one student indicated he or she did nothing before and after every question and, as previously mentioned, one student did not remember doing anything before or after each question. Attempting the question is making most students do a little extra work to either get it correct and/or figure out their mistake. Putting that extra effort into their learning is more likely to move students closer to the learning goal than if they had passively watched a video lesson.

Of the options students marked for work done before or after a question in the first video lesson, most students either re-watched a section of the video or looked something up – both very independent actions. A few asked for help or planned to ask for help, and no one emailed the teacher for help. It is interesting that students in POE and DE chose such independent actions because team work and collaboration are encouraged and valued in these courses. There are several potential reasons the students chose not to collaborate. The most likely culprit is time. Students typically have two school days to complete video lessons, and many procrastinate. It is possible the students do not have time to communicate with someone about the problem and get an answer before the assignment is due. It is also possible that students are in the habit of completing homework assignments independently and simply don't think to ask for help.

Another possibility is that students don't think one question on a video lesson is worth the trouble of asking for help. Whatever the reason, more research may be necessary to determine what is hindering collaboration outside of class.

Another interesting pattern is that POE students were more likely to re-watch a section of the video while DE students were more likely to look something up. This phenomenon could be due to the nature of the video lesson, the nature of the students in these courses, or simply the nature of the students that chose to respond. A much smaller percentage of POE students responded to the survey than DE students, so it is possible that the students in POE that did respond are simply more likely to re-watch the video. Since the survey was anonymous, it is impossible to know if that is the source of the discrepancy. However, after looking carefully at the questions in the two video lessons, it is probable that the source of the discrepancy is the type of questions asked. The video that POE watched that corresponded to the first survey focused on the characteristics of the robotics equipment, such as motors, servos, and potentiometers, that students would need to understand in order to build and program robots for the course. With the exception of one, answers to these questions just required students to recall facts given in the video. The video that DE watched that corresponded to the first survey focused on binary number conversions. The questions asked students to understand the decimal and binary number systems conceptually and perform conversions between the two systems. None of the answers to these questions could be found in the video segments the students had watched before the questions came up, though the process to solve the last three questions, which were simple conversions, could be found in the videos. After comparing the responses for the first

three questions to the last three questions, it is likely the case that it was the nature of the questions that caused DE students to look up information instead of re-watching the video. For the first three questions, students marked that they re-watched the video only 2 times and looked up information 13 times compared to the 9 times they re-watched the video and 3 times they looked something up for the last three questions. Figure 17, below, summarizes these findings.
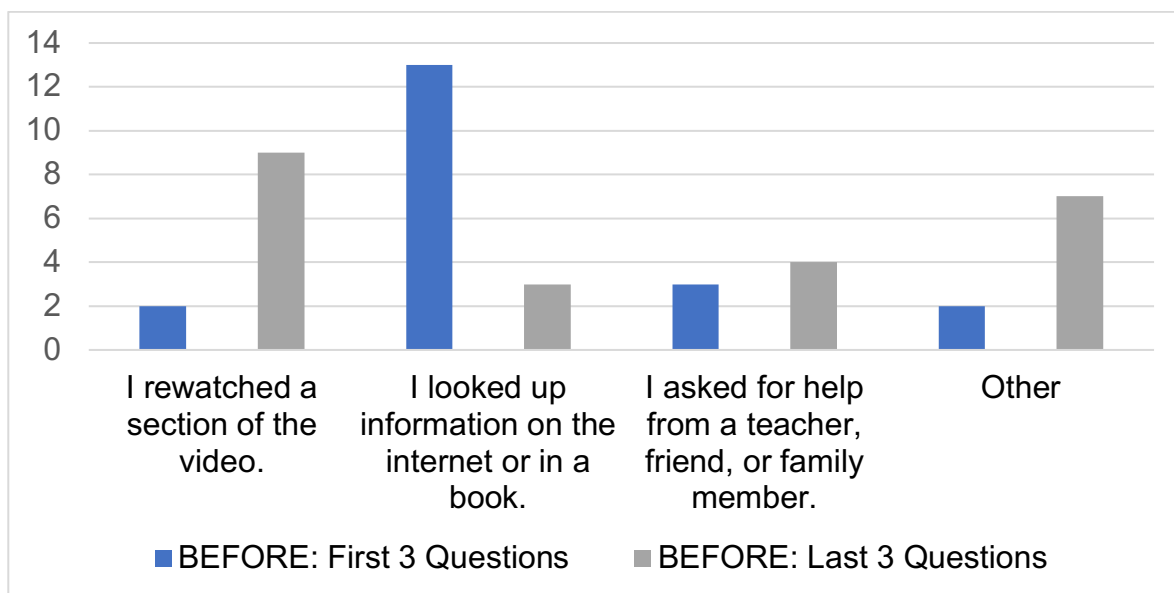
Figure 17. Frequency of DE student responses to what they did, if anything, before trying the example, separated into two groups of questions.

RQ2: How does feedback received from video lessons with questions compare to feedback received from video lessons without questions?

In the second and third video, students were not required to answer questions to move through the video. In the second video, the students were prompted to pause and try a problem five times throughout the video. In 47% of those times, student did not

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pause the video, and 11% of the time, students could not remember pausing the video. In the third video, there were no prompts to pause and try problems even though problems were demonstrated in a way very similar to that of the second video lesson in this study. In both of these videos, students were shown the concept and then shown how to complete applications using that concept. Students were asked if they paused the video to try a problem at any time during the video lesson. 55% of students reported that they did not pause the video, and 9% could not remember pausing the video. Thus, approximately half of the students did not take advantage of opportunities to test their knowledge and get feedback from the instruction in the video, though a few more students paused the video when prompted. While it may not be surprising, it is interesting to have evidence that, when given the option, students will often take the path of least resistance through the video and be passive consumers of knowledge, an issue noted in the original research as well.

In the second survey, students were asked if pausing the video and trying a problem helped them learn. As noted in the results section, students indicated that pausing the video was helpful more times than they actually paused the video to try a problem. These discrepancies came from two students. There are a few potential reasons for this discrepancy. One is that students may have recognized that pausing the video would have been helpful, had they tried. Another is that students may be answering questions in a way that they feel the teacher would expect them to answer. And it is also likely that these two students simply were not paying attention to the questions and thinking critically about their answers. After removing those two students

from the data, there is still evidence that students find working the problem before seeing it explained is helpful for their learning.

Comparing these results to results from the first survey shows that having questions in the video lesson provides students with more feedback. Twelve students responded to the second survey, and there were five opportunities in that video lesson to pause and try a problem. Of these 60 opportunities for feedback interactions, students said that pausing the video to try a problem was very helpful or somewhat helpful for learning only 29 times (22 times after the two students with inconsistent responses were removed). Thirty-one students responded to the first survey and there were six questions in video lesson, thus there were 186 opportunities for feedback interactions. Students indicated that 159 of those opportunities helped them learn. In a video with questions, students felt they had learned approximately 85% of the time and in a video without questions, students received feedback approximately 48% (44% with inconsistent responses removed) of the time. In the second video, students were also asked about what they did before and after their opportunities to work the problems. Comparing these results to the first survey again, students were much more likely to do something extra for required questions than they were for when they were just asked to pause and try a problem.

Because POE students did not take a second survey, the researcher also compared these results for just DE students. As depicted in Figure 18 below, students more often did extra work with required questions than they did without, though the percentages were close for work after the question or example. It is likely that students were reluctant to do extra work, especially beforehand, because they knew the problem

would be worked out for them. Removing questions from the video lesson seems to

discourage students from putting in extra effort required to get students closer to their

learning goal. Thus, while feedback was indirectly available on the videos without

questions, students did not pause to try problems and take advantage of the opportunity

for feedback. It seems that feedback interactions are more likely to occur in video

lessons with required questions that in video lessons without questions, whether the

instructor prompts students to try problems or not.
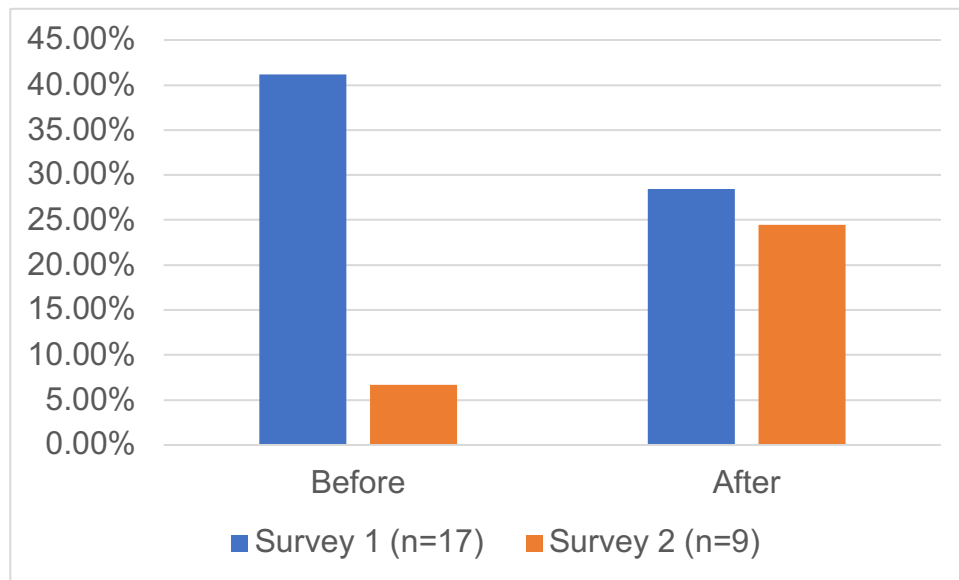
Figure 18. A comparison of the percentage of DE students that did extra work before or after questions in the video lesson versus opportunities to pause and try problems in the video lesson.

RQ3: What are student perceptions about assessment and feedback within the video

lessons?

In the second survey, 75% of students either preferred a video lesson with

questions or had no preference, and 75% of students indicated that questions within the

video lesson help them learn. Students that preferred questions in the video lesson

indicated that they liked having the opportunity to practice and they liked that the questions keep them focused on the lesson. Of the 25% that did not like video lessons with questions, two said that the grade associated with the questions is the problem. One student wrote a confusing answer that led the researcher to believe that the student misinterpreted the question. In the third survey, student preferences among the three options – a video lesson with questions, one with prompts, and one with no prompts – was not as clear. However, approximately 73% of students agreed or strongly agreed that questions within a video lesson help them learn. Student comments in this survey were very similar to the first. Those students that preferred questions within the video lesson most often indicated that the questions force them to stop and practice, which helps them stay focused on the content. Those students that do not like questions within the video lesson indicated that the grade associated with those questions is the problem. This problem was a common theme in the original research as well. Because the biggest drawback to questions in the video lesson is the grade associated with the questions, the instructor has considered giving students a completion grade for the video lesson instead of an accuracy grade. However, it is possible that some students will return to the path of least resistance and quit taking the questions in the video lesson seriously, thus reducing the feedback they receive from those questions. More research will be required to determine if this change is effective.

In the second survey students were asked to provide additional comments. Only two students provided useful additional comments. One student wrote, "I didn't pause the video in order to work on another assignment." It seems that this student may have been trying to get through the assignment quickly or was possibly completing another

assignment at the same time she was watching the video lesson. This may mean

students don't take a video with no questions as seriously as a video with questions.

Another student wrote, "I feel that a question popping up and giving me a chance to get

a grade makes it more likely to do the problem and better understand the content." This

response indicates that students are still motivated by the grade associated with the

questions rather than the potential for learning.

At the end of the third survey, students were asked to respond to the prompt

"Please tell me more about what helps you learn on an Edpuzzle." Five of the seven

responses indicated that questions help them learn, though some students also offered

additional information about how to make those questions more helpful. Two students

indicated that having a few examples worked out before a question is helpful to their

learning. One student took time to carefully explain why she did not learn from

questions within the video lessons. Her concern about getting those questions incorrect

distracts her from the learning. Her answer again suggests that it might be beneficial to

try grading video lessons for completion rather than accuracy. Also, students seem to

like worked examples, so future video lessons could include more worked examples

before students are asked to complete a problem on their own.

Scope and Limitations

This study is limited by its small sample size and by the type of student in the

sample. Because the study was conducted in an elective engineering class, it is not

clear if these results could be generalized to a larger population. Even within the study,

the second and third survey were given only to the third-year students. While the

demographics of the POE and DE students are very similar, it is possible that there are

significant differences between second-year students and the students that choose to remain in engineering into their third-year. Among those differences are motivation, interest, and parental involvement, differences that are not taken into account in this research. It is also interesting to note that there was a large drop in participation in the DE class from the first survey to the second and third. The video lesson that corresponded to the first survey was preceded by a large team project, so students were getting back into the habit of watching video lessons and may have been more motivated to complete it promptly than they were by the second and third video lesson in that unit. It is also possible that these students just grew tired of completing surveys. These surveys were also optional, which could affect the generalizability of the results. The type of student that completed the first survey and then continued to complete additional surveys could skew the data.

Though this study does indicate that students are getting feedback at home, the quality of feedback is not clear, and the study does not determine if students are internalizing the feedback they get. Also, while the original research compared a flipped classroom to a traditional classroom, this research did not consider potential for at-home feedback on traditional homework. It is possible students could get just as much feedback from traditional homework.

Future Research

The next step in this research would be to determine what happens when video lessons are graded for completion. It is clear that video lessons with required questions deliver feedback better than video lessons without questions. However, there are still some students with valid concerns about the grade associated with those questions. It

is also interesting that students are not collaborating outside of class. More research

should be done on why students are unwilling to ask others for help on homework

assignments and what can be done to encourage collaboration without encouraging

cheating. More research is also needed on at-home feedback in a traditional classroom

setting.

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LIST OF APPENDICES

APPENDIX A

Principles of Engineering Informed Consent

Consent for Your Child to Participate in Research

Study Title: *Feedback in the Flipped Classroom*

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Purpose of the Study
The flipped classroom model is a technique in education where the instruction is given as homework, usually through a video students watch at home, and class time is used for engaging activities and practice with that information. I want to know if students get more feedback on their classroom progress, both from the teacher and other students, when we use the flipped classroom model.

What your child will do for this study
Feedback interactions among students and between students and the teacher will be observed during the normal class period via recordings, which are described below in more detail. Students will be requested to act and speak like they normally would during class. Nothing a student says on the recording will affect his or her grade in the class.

Students will be observed for two units of study and recorded for at least three class blocks in each unit. In one unit of study, your child will continue to be taught using the flipped classroom method. In the other unit, your child will be taught using a traditional classroom model. The classroom procedures will not change during the study.

After the observations are completed, students will be asked to voluntarily take an anonymous survey. No question on the survey is required, so students may start the survey and then choose to skip questions they do not want to answer. Students will be asked to indicate whether they prefer flipped or traditional instructions. Students also will be asked if they strongly disagree, disagree, are neutral, agree, or strongly agree with several statements about the flipped classroom. These statements include, but are not limited to, the following:
- I find it easier to ask the teacher questions in the flipped classroom.
- The interactions I have with the teacher in a flipped classroom are more helpful than the interactions I have with a teacher in a traditional classroom.
- The teacher spends more time helping me in a flipped classroom.

Videotaping / Audiotaping
Students will be audio and/or video recorded during their normal class session. There will be a camera filming the entire class. Small groups will also be audio and/or video recorded using software on school devices.

Time required for this study
Recordings will take 1.5 hours each day. Principles of Engineering students will be recorded at least 6 times, for a total of 9 hours of recording. These recordings will happen during their normal class block, so will take no time outside of class. The survey will take 10-20 minutes.

Possible risks from participation
There are no anticipated risks to you from participating in the study.

Benefits from participation
Your child should not expect benefits from participating in this study. However, your child might experience satisfaction from contributing to scientific knowledge. Also, answering the survey questions might make your child more aware of feedback he or she is receiving in the classroom, thus making him or her more prepared to learn from and act on feedback.

Confidentiality
    a. Research team members will have access to records from this study.
    b. Members of the Institutional Review Board (IRB) – the committee responsible for reviewing the ethics of, approving, and monitoring all research with humans – have authority to access all records. However, the IRB will request identifiers only when necessary. We will not release identifiable results of the study to anyone else without your written consent unless required by law.
    c. Please note that the survey will remain completely anonymous and will not ask for any identifying information.

Confidentiality and Use of Video/Audio Tapes
    • The audio and video recordings will help me accurately count and time the feedback interactions in class without taking away valuable class time. I can review the data later so that while I am teaching, my full focus is on my students.
    1. Only my faculty advisors and teachers involved in the study will have access to the video and audio recordings.
    2. During the study, recordings will be stored on my Google Drive, which is password protected and only accessible by me.
    3. Recordings will be kept until completion of all necessary parts of the study, but no longer than May of 2019.

Right to Withdraw

Your child does not have to participate in this study, and there is no penalty if he or she refuses. If your

child starts the study and either one of you decides that you do not want to finish, just tell the

teacher/researcher. Whether or not your child participates or withdraws will not affect your current or

future relationship with Northwest Rankin High School or the University of Mississippi, and it will not

cause you to lose any benefits to which you are entitled.

Student Participants in Investigators' Classes

Special human research subject protections apply where there is any possibility of coercion – such as for

students in classes of investigators. Investigators can recruit from their classes but only by providing

information on availability of studies. They can encourage you to participate, but they cannot exert any

coercive pressure for you to do so. Therefore, if you experience any coercion from your instructor, you

should contact the IRB via phone (662-915-7482) or email (irb@olemiss.edu) and report the specific form

of coercion. You will remain anonymous in an investigation.

IRB Approval
This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). The
IRB has determined that this study fulfills the human research subject protections obligations required by
state and federal law and University policies. If you have any questions or concerns regarding your rights
or your child's rights as a research participant, please contact the IRB at (662) 915-7482 or
irb@olemiss.edu.

Please ask the researcher if there is anything that is not clear or if you need more information. When all

your questions have been answered, then decide if you want your child to be in the study or not.

Statement of Consent

I have read the above information. I have been given an unsigned copy of this form. I have had an

opportunity to ask questions, and I have received answers. I consent to allow my child to participate.

Furthermore, I also affirm that the researcher explained the study to me and told me about the study's

risks as well as my right and my child's right to refuse to participate and to withdraw, and that I am the

parent/legal guardian of the child listed below.

_____   _____   _____

Parent/Legal Guardian Signature   Student Signature   Date

_____   _____

Printed name of Parent/Legal Guardian Printed name of Student

NOTE TO PARTICIPANTS: DO <u>NOT</u> SIGN THIS FORM

IF THE IRB APPROVAL STAMP ON THE FIRST PAGE HAS EXPIRE

AP Statistics Informed Consent

Consent for Your Child to Participate in Research

Study Title: *Feedback in the Flipped Classroom*

Investigator
Trisha Gilbreath

Engineering & Mathematics Instructor
Northwest Rankin High School
5805 Highway 25
Flowood, MS 39232
(601) 992-2242
trisha.gilbreath@rcsd.ms

Faculty Sponsor
Dr. Allan Bellman

Department of Education
320 Guyton Hall
University of Mississippi
University, MS 38677
(662) 915-5309
abellman@olemiss.edu

Purpose of the Study
The flipped classroom model is a technique in education where the instruction is given as homework, usually through a video students watch at home, and class time is used for engaging activities and practice with that information. I want to know if students get more feedback on their classroom progress, both from the teacher and other students, when we use the flipped classroom model.

What your child will do for this study
Feedback interactions among students and between students and the teacher will be observed during the normal class period via recordings, which are described below in more detail. Students will be requested to act and speak like they normally would during class. Nothing a student says on the recording will affect his or her grade in the class.

Students will be observed for one class block where the teacher uses the flipped classroom method as usual. The classroom procedures will not change during the study.

After the observations are completed, students will be asked to voluntarily take an anonymous survey. No question on the survey is required, so students may start the survey and then choose to skip questions they do not want to answer. Students will be asked to indicate whether they prefer flipped or traditional instructions. Students also will be asked if they strongly disagree, disagree, are neutral, agree, or strongly agree with several statements about the flipped classroom. These statements include, but are not limited to, the following:

- I find it easier to ask the teacher questions in the flipped classroom.
- The interactions I have with the teacher in a flipped classroom are more helpful than the interactions I have with a teacher in a traditional classroom.
- The teacher spends more time helping me in a flipped classroom.

Videotaping / Audiotaping
Students will be audio and/or video recorded during their normal class session. There will be a camera filming the entire class. Small groups will also be audio and/or video recorded using software on school devices.

Time required for this study
Recording will take 1.5 hours, or the length of the class block. These recordings will happen during their normal class block, so will take no time outside of class. The survey will take 10-20 minutes.

Possible risks from participation
There are no anticipated risks to you from participating in the study.

Benefits from participation
Your child should not expect benefits from participating in this study. However, your child might experience satisfaction from contributing to scientific knowledge. Also, answering the survey questions might make your child more aware of feedback he or she is receiving in the classroom, thus making him or her more prepared to learn from and act on feedback.

Confidentiality
   d. Research team members will have access to records from this study.
   e. Members of the Institutional Review Board (IRB) – the committee responsible for reviewing the ethics of, approving, and monitoring all research with humans – have authority to access all records. However, the IRB will request identifiers only when necessary. We will not release identifiable results of the study to anyone else without your written consent unless required by law.
   f. Please note that the survey will remain completely anonymous and will not ask for any identifying information.

Confidentiality and Use of Video/Audio Tapes
   • The audio and video recordings will help me accurately count and time the feedback interactions in class without taking away valuable class time. I can review the data later so that while I am teaching, my full focus is on my students.
   4. Only my faculty advisors and teachers involved in the study will have access to the video and audio recordings.
   5. During the study, recordings will be stored on my Google Drive, which is password protected and only accessible by me.
   6. Recordings will be kept until completion of all necessary parts of the study, but no longer than May of 2019.

Right to Withdraw

Your child does not have to participate in this study, and there is no penalty if he or she refuses. If your child starts the study and either one of you decides that you do not want to finish, just tell the teacher/researcher. Whether or not your child participates or withdraws will not affect your current or future relationship with Northwest Rankin High School or the University of Mississippi, and it will not cause you to lose any benefits to which you are entitled.

Student Participants in Investigators' Classes

Special human research subject protections apply where there is any possibility of coercion – such as for students in classes of investigators. Investigators can recruit from their classes but only by providing information on availability of studies. They can encourage you to participate, but they cannot exert any

coercive pressure for you to do so. Therefore, if you experience any coercion from your instructor, you

should contact the IRB via phone (662-915-7482) or email (irb@olemiss.edu) and report the specific form

of coercion. You will remain anonymous in an investigation.

IRB Approval
This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). The
IRB has determined that this study fulfills the human research subject protections obligations required by
state and federal law and University policies. If you have any questions or concerns regarding your rights
or your child's rights as a research participant, please contact the IRB at (662) 915-7482 or
irb@olemiss.edu.

Please ask the researcher if there is anything that is not clear or if you need more information. When all

your questions have been answered, then decide if you want your child to be in the study or not.

Statement of Consent

I have read the above information. I have been given an unsigned copy of this form. I have had an

opportunity to ask questions, and I have received answers. I consent to allow my child to participate.

Furthermore, I also affirm that the researcher explained the study to me and told me about the study's

risks as well as my right and my child's right to refuse to participate and to withdraw, and that I am the

parent/legal guardian of the child listed below.

_____   _____   _____

Parent/Legal Guardian Signature   Student Signature   Date

_____   _____

Printed name of Parent/Legal Guardian Printed name of Student

NOTE TO PARTICIPANTS: DO <u>NOT</u> SIGN THIS FORM

IF THE IRB APPROVAL STAMP ON THE FIRST PAGE HAS EXPIRED

Interview Informed Consent

Consent for Your Child to Participate in Research Interview

Study Title: *Feedback in the Flipped Classroom*

Investigator   **Faculty Sponsor**
Trisha Gilbreath   Dr. Allan Bellman

Engineering & Mathematics Instructor   Department of Education
Northwest Rankin High School   320 Guyton Hall
5805 Highway 25   University of Mississippi
Flowood, MS 39232   University, MS 38677
(601) 992-2242   (662) 915-5309
trisha.gilbreath@rcsd.ms   abellman@olemiss.edu

Purpose of the study
The flipped classroom model is a technique in education where the instruction is given as homework, usually through a video students watch at home, and class time is used for engaging activities and practice with that information. I want to know if students get more feedback on their classroom progress, both from the teacher and other students, when we use the flipped classroom model.

What your child will do for this study
Your child has been chosen to be interviewed to learn more about the student perspective on the flipped classroom. Nothing a student says in the interview will affect his or her grade in the class. Students will be asked questions like the following:

1. Talk about your favorite flipped classroom experience. What made it so enjoyable?

2. Talk about your worst flipped classroom experience. What made it so terrible?

3. What happens when a teacher can't answer your question immediately in class?

4. What is the difference between the answers you get from a teacher versus the answers you

get from other students?

Videotaping / Audiotaping
Student interviews will be audio recorded.

Time required for this study
Student interviews should take approximately 30 minutes.

Possible risks from participation
There are no anticipated risks to you from participating in the study.

Benefits from participation
Your child should not expect benefits from participating in this study. However, your child might experience satisfaction from contributing to scientific knowledge. Also, answering the interview questions

might make your child more aware of feedback he or she is receiving in the classroom, thus making him or her more prepared to learn from and act on feedback.

Confidentiality
    g. Research team members will have access to records from this study.
    h. Members of the Institutional Review Board (IRB) – the committee responsible for reviewing the ethics of, approving, and monitoring all research with humans – have authority to access all records. However, the IRB will request identifiers only when necessary. We will not release identifiable results of the study to anyone else without your written consent unless required by law.

Confidentiality and Use of Video/Audio Tapes
- The audio recording will allow me to review the interview and note important information that might be missed during the interview process.
7. My faculty advisors and teachers involved in the study will have access to the audio recordings.
8. Students interviewed will not be asked to identify themselves and will be reminded to not share any identifying information during the interview.
9. Recordings will be kept until completion of all necessary parts of the study, but no longer than May of 2019.
10. Recordings will be stored on my Google Drive, which is password protected and only accessible by me.

Right to Withdraw

Your child does not have to participate in this study, and there is no penalty if he or she refuses. If your child starts the study and either one of you decides that he or she should not finish it, just tell the teacher/researcher. Whether or not your child participates or withdraws will not affect your current or future relationship with Northwest Rankin High School or the University of Mississippi.

Student Participants in Investigators' Classes

Special human research subject protections apply where there is any possibility of coercion – such as for students in classes of investigators. Investigators can recruit from their classes but only by providing information on availability of studies. They can encourage you to participate, but they cannot exert any coercive pressure for you to do so. Therefore, if you experience any coercion from your instructor, you should contact the IRB via phone (662-915-7482) or email (irb@olemiss.edu) and report the specific form of coercion. You will remain anonymous in an investigation.

IRB Approval
This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). The IRB has determined that this study fulfills the human research subject protections obligations required by

state and federal law and University policies. If you have any questions or concerns regarding your rights or your child's rights as a research participant, please contact the IRB at (662) 915-7482 or irb@olemiss.edu.

Please ask the researcher if there is anything that is not clear or if you need more information. When all

your questions have been answered, then decide if you want your child to be in the study or not.

Statement of Consent

I have read the above information. I have been given an unsigned copy of this form. I have had an

opportunity to ask questions, and I have received answers. I consent to allow my child to participate.

Furthermore, I also affirm that the researcher explained the study to me and told me about the study's

risks as well as my right and my child's right to refuse to participate and to withdraw, and that I am the

parent/legal guardian of the child listed below.

_____ _____ _____

Parent/Legal Guardian Signature   Student Signature   Date

_____ _____

Printed name of Parent/Legal Guardian Printed name of Student

NOTE TO PARTICIPANTS: DO <u>NOT</u> SIGN THIS FORM

IF THE IRB APPROVAL STAMP ON THE FIRST PAGE HAS EXPIRED

Information Sheet for Adult Participant

INFORMATION SHEET

Title: Feedback in the Flipped Classroom

Investigator	**Advisor**
Trisha Gilbreath	Dr. Allan Bellman
Engineering & Mathematics Instructor	Department of Education
Northwest Rankin High School	320 Guyton Hall
5805 Highway 25	The University of Mississippi
Flowood, MS 39232	(662) 915-5309
(601) 992-2242	abellman@olemiss.edu
trisha.gilbreath@rcsd.ms	

By checking this box, I certify that I am 18 years of age or older.

Description

I am researching the flipped classroom model. I want to know if students get more feedback on their classroom progress, both from the teacher and other students, when we use the flipped classroom model. One of your classes will be observed and recorded so that I can count and time feedback interactions. I would also like to interview you about your experience using the flipped classroom model.

Cost and Payments

There are no costs or payments associated with this study. The interview will take approximately 30 minutes. The classroom observations should take no extra time out of your day.

Risks and Benefits

There are no anticipated risks. There are no direct benefits, though you might experience satisfaction from contributing to scientific knowledge. Also, answering the interview questions might help you self-reflect on the flipped classroom model.

Confidentiality

Your interview will be audio recorded. You will not be asked to share any identifying information during the interview. Recording will be kept until completion of all necessary parts, but no longer than May of 2019.

Right to Withdraw

You do not have to take part in this study and you may stop participation at any time. If you start the study and decide that you do not want to finish, all you have to do is to tell Ms. Gilbreath or Dr. Bellman in person, by letter, or by telephone (contact information listed above). You may skip any questions you prefer not to answer.

IRB Approval

This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). If you have any questions, concerns, or reports regarding your rights as a participant of research, please contact the IRB at (662) 915-7482 or irb@olemiss.edu.

Statement of Consent

I have read and understand the above information. I consent to participate in the study.

Release of Rights to Recorded Information

I release all rights, including copyright rights for the use of recorded or written

information that I provided in this interview. With this release, I grant the University of

Mississippi and Trisha Gilbreath permission to use, reproduce, copy, and distribute my

words in whole or in part into derivative works without limitation. I indemnify and hold

the University of Mississippi and the researchers harmless from any claims of

infringement of copyrights by any third party regarding my words. I agree that I will

receive no further consideration and no royalty payments for the use of my words.

Name: _____

Address: _____

Phone Number: _____

Signature: _____

APPENDIX E

School District Consent for Research

RANKIN COUNTY
SCHOOL DISTRICT
GREAT TO BEST

Post Office Box 1359 • Brandon, MS 39043 • p 601.825.5590 • f 601.825.2618 • www.rcsd.ms

February 7, 2018

Ms. Trisha Gilbreath
308 Louis Lane
Brandon, MS 39047

RE: Research

Dear Ms. Gilbreath,

My team has reviewed your information regarding your research study and survey. I am pleased to grant you permission to conduct your research study and survey at Northwest Rankin High School as outlined in the research. Both parents and students **must** consent to participate.

Best wishes in your educational endeavors.

Sincerely,

Sue Townsend, Ph.D.
Superintendent of Education
Rankin County School District

Dr. Sue Townsend
Superintendent of Education

APPENDIX F

Student Survey Questions

Instructions: Compare your experience in a flipped classroom versus that of a traditional classroom. All questions are optional.

1. Which classroom model do you prefer?

    a. Traditional Classroom – the teacher does instruction during class

    b. Flipped Classroom – instruction is completed as homework

    c. No preference

    d. Depends on the lesson

2. Why do you have this preference? (Open answer)

Likert Scale questions: 1 (strongly disagree) – 5 (strongly agree)

3. I find it easier to ask the teacher questions in the flipped classroom.

4. In a flipped setting, the teacher is more likely to address my questions than the same teacher in a traditional setting.

5. The interactions I have with the teacher in a flipped classroom are more helpful than the interactions I have with a teacher in a traditional classroom.

6. The teacher spends more time helping me in the flipped classroom.

7. I find it easier to ask other students questions in the flipped classroom.

8. In a flipped setting, students are more likely to answer my questions than the students in a traditional setting.

9. The interactions I have with other students in a flipped classroom are more helpful than the interactions I have with other students in a traditional classroom.

10. Students spend more time helping me in a flipped classroom.

APPENDIX G

Interview Questions for Students

1. Talk about your favorite flipped classroom experience. What made it so enjoyable?

2. Talk about your worst flipped classroom experience. What made is so terrible?

3. What do you notice about interactions with your teacher in the flipped classroom?

4. What do you notice about interactions with other students in the flipped classroom?

5. What happens when a teacher can't answer your question immediately in class?

6. What is the difference between the answers you get from a teacher versus the

answers you get from other students?

APPENDIX H

Interview Transcript with Jack

RESEARCHER: Ok, so I'm going to ask you some questions about the flipped classroom, and don't say your name at any point during the interview because it is supposed to be anonymous, and that's about it. So, when I say flipped classroom, I'm talking about when we do Edpuzzles for homework and then we do, like, activities in class. And then traditional is when I lectured in class. Ok, so, talk about your favorite flipped classroom experience and what made it so enjoyable.

JACK: My favorite one was, I think the vectors. That was when we did the vector Edpuzzle. Um, I just liked that one because the Edpuzzle explained it pretty well and then it made the activity was pretty self-explanatory from the Edpuzzle. And then I liked that because then once you get the lesson then you can go at your own pace on the activity.

RESEARCHER: What about your worst flipped classroom experience? What made it so terrible?

JACK: Was trusses a flipped one?

RESEARCHER: Trusses was traditional. (Then I move the computer to get less background noise.)

JACK: What were all the flipped ones?

RESEARCHER: Oh gosh, we did flipped for most of the year. So, I'm thinking of Edpuzzles. Actually, I don't have to think of Edpuzzles, we can just go to Edpuzzle and see what you had Edpuzzles on.

JACK: Wasn't, was the gears one of them?

RESEARCHER: Gears was.

JACK: That was one I didn't like. The gears I didn't like because that one was just one of the harder subjects, and that was one where I needed, like it would have been better to have you there so where I could ask questions about, and I feel like sometimes when a certain person doesn't understand it, then, like, you can change how you explain it to be able to get them to understand it better. But when, like, when you're not there, if you don't understand it, you don't, you just don't understand it.

RESEARCHER: That makes sense. The next couple questions are going to be about interactions – interactions between you and the teacher and interactions between you and other students. During a flipped classroom, what do you notice about interactions between you and the teacher?

JACK: Uh, I think interactions between me and the teacher are less likely just because, like, the activities are more independent or with your group, so whenever we do flipped classrooms, you're more likely to get help from students than teachers.

RESEARCHER: So, I'm going to add that to number four because my next question is what do you notice about interactions with students in the flipped classroom?

JACK: Interactions with students would be more likely just because, like, they are already there and they have done the same Edpuzzle that you did so it's easier, like, if they understand they can explain it to you and you're working together so it's like, if somebody understands one part, they explain it to you and if you understand the other part, then, like, you can explain it to them. So, it's kind of like mutual teaching, I guess.

RESEARCHER: Mutual teaching, I like that phrase. What happens in class when the teacher can't immediately answer your question?

JACK: I think the first thing would be to go to a student who you know understands it. Cause I feel like students are more likely to be able to explain it to you in easier terms than a teacher would be. So if you don't understand what your teacher said, you just go to a student.

RESEARCHER: What is the difference between answers you get from a teacher and answers you get from other students?

JACK: I think answers from teachers are just more professional, I guess. You use more professional terms. And I feel like students, sometimes, students sometimes find shortcuts to things that aren't necessarily the way the teacher taught it, but they may be easier to understand.

RESEARCHER: Just in general, is there anything you want to share about flipped classroom that you think, like, me as a teacher that I need to know, that might improve my teaching?

JACK: I think it's just kind of, like for me, I was thinking about it and you can do the same, like you can see the same thing from both perspectives. Using the Edpuzzle, you don't get the teacher's input in the lesson, but you get more of the teacher's input on specific problems in the activity, but then if you're teaching, then you can ask questions during the lesson as well as the activity. So, I guess, I kind of like whenever you're teaching better just because it's easier to ask questions and it's easier to make sure you understand it before you get to the activity.

RESEARCHER: That makes sense. Okay, that is it. Thank you very much for agreeing to interview.

APPENDIX I

Interview Transcript with Rory

RESEARCHER: Thank you for agreeing to participate in the interview.

RORY: You're welcome.

RESEARCHER: Don't say your name at any point during the interview.

RORY: Okay.

RESEARCHER: Because this is supposed to be anonymous.

RORY: Okay.

RESEARCHER: Except, obviously, I know who you are.

RORY: Obviously.

RESEARCHER: I'm going to talk about flipped classroom versus traditional classroom. And the flipped classroom is what we usually do, and then traditional is when I actually lectured in front of the class and y'all took notes in class. So, we did that just for one unit. So, talk about your favorite flipped classroom experience and what made it so enjoyable.

RORY: I'm a nerd. I feel that's necessary to state for (unintelligible). So, when we were doing programming, I really wanted to learn programming and so I watched those Edpuzzles over and over again because I wanted to make sure I understood that, and that's not something you can really do with a traditional lecture cause, like, you can't turn back time and watch it over again. And then just the, like, little references you put in your questions are always nice to see.

RESEARCHER: I do try to make it fun.

RORY: Yeah, and that, that lightens it up a bit, which is nice.

RESEARCHER: What about your worst flipped classroom experience and what made it so terrible?

RORY: Ooh, that's a hard question. [long pause] I can't think of any. The only time I've had bad flipped classroom experiences is when I just didn't do the Edpuzzle, and I showed up, and I was like, "I don't know what I'm doing."

RESEARCHER: That's fair. If you think of one while we're talking, just interrupt me.

RORY: Yeah, I will.

RESEARCHER: Next I'm going to ask you about interactions. So, we're going to start with what do you notice about interactions between your teacher and you during the flipped classroom experience?

RORY: I would say they were a little bit lessened, but, in a good way because I'm not a fan of lectures. Actually, no, now that I think about it, it's probably more, because you're just replacing the lecture with an Edpuzzle, and an Edpuzzle you can watch over again. And a traditional lecture isn't much interaction. It's kind of just like a here's the information and an Edpuzzle is kind of interactive, but it probably didn't change much. It was just instead of being there in person with the professor, they're on a computer screen.

RESEARCHER: Yeah, that makes sense. What about interactions with your fellow students during the flipped classroom?

RORY: There are probably more of them. Yeah, more of them, because with a traditional classroom, you do your work at home, and so you maybe text your buddy if you needed homework help or something like that. But in class they're sitting right next to you, so if you have any questions, you can work through it together, and that's very

nice because over text it's much harder to explain things than in person when you can show them and write it out.

RESEARCHER: Absolutely. I agree with all of that. Now let's think about, just in any class, flipped or traditional, what happens when a teacher can't answer your question immediately during class?

RORY: Hm. Usually I'll end up Googling it in the end. Yeah, if a question can't be answered by a teacher, Google has the answer most of the time.

RESEARCHER: Usually. So, do you see any difference in a flipped classroom versus a traditional classroom? Do you think there is any difference in what you do or what students do when the teacher can't answer their question immediately?

RORY: Well, probably not. Yeah, I can't think of any questions the teacher wouldn't be able to answer that wouldn't be solved through means other than Google.

RESEARCHER: Okay, and then the answers you get when you do ask a question and you actually get the answer. What's the difference between the answers you get from a teacher versus the answers you get from other students?

RORY: Sometimes the answers you get, and this is not necessarily you, in general, the answers you get from a teacher, the teacher will just repeat what they said already and not try to change it and rephrase it. But if you ask a fellow student, then if they understand the information, they'll put it into their own words, which is more often closer to your own words. So, it's beneficial to ask your peers if you don't understand it.

RESEARCHER: Yeah. Do you..What do you think about... Well, I don't want to ask about me, because I don't want you to feel like you have to tell me anything about me.

What about me? If you don't mind. If you do mind, don't answer. But when I answer your questions in class, am I rephrasing or am I repeating? Because I'm curious.

RORY: I don't think I've ever asked you much of a question in class. I can't think of a specific instance in which either situation has happened. Because, especially with the Edpuzzles, normally if I have a question, I'll just rewind the Edpuzzle and I'll get it answered. So, I don't really remember any instance where that's happened with you.

RESEARCHER: Okay. Yeah, I was just curious, because that's good information. Being careful not, as a teacher, to think and rephrase, not just repeat. That's really good. That's what I've got. Do you have anything you want to talk to me about, anything I didn't ask you about the flipped classroom that you would like to share?

RORY: Not really. Definitely the best thing about Edpuzzles is that you can re-watch them. And you can go back in time, because sometimes you just need to hear it twice. And obviously, in class, that's not a very fun thing for a teacher to do, to literally repeat themselves. And so sometimes just rewinding it and watching it over again is very beneficial.

RESEARCHER: Cool.

RORY: And it's also nice to have a lecture integrated with questions, which you can do with a normal lecture, but it's nice to have questions on what you had and if you need to, you can rewind two minutes back and learn that specific information again. And then answer a question on it.

RESEARCHER: Yeah, I've read that students... That's actually two things I've read from students. They like the ability to re-watch, and having integrated questions is really important. Well, thank you!

RORY: You're welcome.

APPENDIX J

Interview Transcript with Amy

RESEARCHER: I'm going to ask you questions about flipped classroom versus traditional classroom. And when I say flipped classroom, that's when you had to watch Edpuzzles at home and then we did activities in class. So, it's what we normally do. And then traditional classroom is when I lectured in class and then you did activities for homework. My first question is talk about your favorite flipped classroom experience and what made it so enjoyable?

AMY: Ooh. I think it was the lesson when we were first learning about stress and strain. So, that was pretty interesting because you kind of just told us, "Here's the formula sheet and here's what you kind of need to know," and then just kind of let us do it.

RESEARCHER: So, you liked that freedom of just, "Here. Here's a formula sheet. You can do this."?

AMY: Yeah.

RESEARCHER: On the flip side, talk about your worst flipped classroom experience and what made it so terrible.

AMY: Ooh. Probably around the time when we had to do trusses. Trusses are just awful, and it was a lot to do at once and if you mess one thing up, then you'd mess the whole thing up, and the whole thing was counted wrong, so that was stressful.

RESEARCHER: Okay, now I want to talk about interactions. What do you notice about interactions with your teacher in a flipped classroom setting?

AMY: I feel like a lot more questions were presented to the teacher because a lot of the time they would watch the Edpuzzles haphazardly. I noticed that a lot amongst my

peers. And they would have a lot of questions. At one point, it was before we learned

trusses, when we were learning vectors and the senses, a lot of them didn't know what

a sense was because they didn't really pay attention to the provided Edpuzzles.

RESEARCHER: I can't write fast enough. Okay, what about interactions with other

students during a flipped classroom setting.

AMY: Well usually in maybe each team the teacher would try to put together people

who kind of had a sense of what they were doing or she knew that they probably did

their work. And then a lot of the people, the people who didn't know what they were

doing, would ask them and they would have to explain, or they would ask the teacher.

RESEARCHER: So, the people who didn't know what they were doing would have to

ask other students or the teacher what was going on.

AMY: Yeah.

RESEARCHER: Okay. [Pause to write.] Think about when the teacher can't

immediately answer your question during class. What usually happens when the

teacher can't immediately answer a question you have.

AMY: Usually she would look it up herself and do research on it or we'd look it up.

RESEARCHER: Okay. And then thinking about the answers you get from the teacher

versus the answers you get from other students when you do ask a question, what's the

difference between the answers you get from the teacher versus the answers you get

from other students?

AMY: The teacher, she gives out her answers consistently, and if we have a question,

then we have to ask. Some students might explain it differently because they don't know

how to explain and teach like the teacher does. But some students are good at

explaining it. It really depends on which student you ask. And then sometimes students just shouldn't be explaining things and shouldn't be talking.

RESEARCHER: So, it kind of depends on the student whether you are going to get a quality explanation versus a non-quality explanation.

AMY: Yes, ma'am.

RESEARCHER: Is there anything about the flipped classroom that stands out or you think I should know as at teacher that could maybe make it better? Something that's making it worse?

AMY: Hm. [long pause] With flipped classrooms, a lot of the times, it could stop cheating with homework. Because, you know, we'd have different homework, and then one person would be like, "Hey, what'd you get on this and I'll give you this." But with the flipped classrooms, it changed that. Or how it was broken up between the two classes. You know some students trade answers. But then it also made it hard when you didn't know a subject and the only person that you kind of talk to in your classroom doesn't know either, so we try to ask the other students from the other class, different class, and they don't know what we're talking about and it's really like, "I don't know what's going on".

RESEARCHER: And comparing interactions, good interactions, interactions that help you actually learn, not just talking about the weather, but things that help you learn what's going on, do you feel like it was easier to talk and interact and get good interactions in a flipped classroom or in a traditional classroom?

AMY: Probably traditional, just because it's more lecture-based. And, you know,

afterwards we could probably have time because notes sometimes don't take that long.

We could discuss amongst ourselves why this is this or we could just ask the teacher.

RESEARCHER: Okay. Anything else you want to share?

AMY: No, ma'am.

RESEARCHER: Okay. Thank you. That's it!

APPENDIX K

Teacher Interview Questions

1. To what extent is it easier or more difficult to give feedback in a flipped class over a traditional class?

2. What elements of the flipped classroom model affect feedback?

3. Compare your ability to give feedback to students in the flipped classroom versus the traditional.

4. Compare the quality of the feedback you are able to give to students in the flipped versus the traditional class.

5. To what extent are students providing quality feedback to each other?

6. What happens when you delay feedback, either by design or because you are busy with other students?

APPENDIX L

Interview Transcript with Mrs. Hiddleston

RESEARCHER: This is our interview about the flipped classroom. To what extent is it easier or more difficult to give feedback in a flipped classroom over a traditional classroom?

MRS. HIDDLESTON: Hm. Well, I like the feature of the Edpuzzle that allows you to input the feedback as they answer wrong, so that's helpful because I'm not there with them as they're doing it. So, I can put the feedback in like, "No, this isn't the right answer because da da da da da." What I don't necessarily love is they do this at home, they come back the next day and I'm like, "Okay, let's talk. Tell me what you need help on." And sometimes it's like crickets because it's maybe been almost two days since they did the Edpuzzle, if they did it the first night it was assigned. Then they are sitting there going, "Uh. I don't remember what I need help on." Which, you know, once we get to the actual work or activity of the day that's going to apply that, it becomes evident, but, yeah, they have a harder time giving me the feedback when they come back to class about what they need help on until we get started on something, and then I discover it for myself.

RESEARCHER: So, it's like they have trouble knowing what they need help with until they get started.

MRS. HIDDLESTON: Right. In stats, most of my flipped videos are conceptual, vocab, like, "Hey. Here's the idea we're about to start working with and these are the formulas and where they came from." But they are not really asked to apply that in the video. They are just getting the basics of the vocab and the idea itself in the video. So, they

really don't necessarily know whether they really understood it until they start trying to work the problems in class.

RESEARCHER: That makes sense. I think I have a follow-up question, but I might have to think it through for a second.

MRS. HIDDLESTON: Okay.

RESEARCHER: Okay. I'm going to go to my next question. And we kind of got into this. What elements of the flipped model affect feedback? So, you kind of get into that, but talk about it some more if you can.

MRS. HIDDLESTON: Okay, say that question again.

RESEARCHER: What elements of the flipped classroom affect feedback?

MRS. HIDDLESTON: I threw an extra word in that sentence, and I was confused. I did get into that a little bit already. [Pause]

RESEARCHER: So, how long it's been since they watched the video was one thing.

MRS. HIDDLESTON: That's one thing. The fact that what I'm asking them to do at home is really vocab and conceptual. They don't know yet, and I haven't asked them to do anything with it yet, so the feedback really doesn't come until we get into something. And then they get to step two and they are like, "Wait, what? I remember this from the video but I don't know how to do it."

RESEARCHER: So, the feedback comes when they start the application

MRS. HIDDLESTON: Right.

RESEARCHER: When you think about, if you were to do traditional classrooms, or the times you do traditional classrooms, when you lecture with vocab and concepts and you have less time in class for applications. So, do you feel like the flipped classroom,

because it gives you more time for the applications, it gives you more time to give feedback or do you feel like it's about the same?

MRS. HIDDLESTON: No, definitely more time for feedback with the flipped because if I have to spend a good 30 minutes going through, "This is the concept of the vocab," and if I'm going to do it without a flipped model, then I'm going to work through a problem with them. Which, that takes longer live then it does for them to watch it happen in a video, because I'll ask them to kind of help follow along, and write down, and what do you think the next step would be?

RESEARCHER: Yep, I've noticed that too. Just lecturing takes longer live than it takes on the video period, in my experience. Let's talk about quality of feedback. Compare the quality of feedback you are able to give to students in the flipped versus the traditional classroom. Do you think the quality differs?

MRS. HIDDLESTON: Yeah, I think both quantity and quality differs. With traditional classroom, if I have to sit there and go through the notes and work through a problem with them, I'm going, "Do you understand?", "Do you know what to do?", and I get head nods. And then I'm like, "Okay, do this one on your own." Well, by the time they do one or two on their own, there's not a lot of time for me to go around and check every single person's work. It's a lot of writing. It's a lot of work in stats. It's not feasible for me to go around to every single person and double check, and so I'm just trusting that if they're not asking me questions, or if I'm walking around and I'm not seeing them struggle, I'm having to trust that they are understanding the process. Or I have to try and give a quiz, which means they are not going to get the feedback on that until next time. But with the flipped classroom, we get right into the application. And so, it gives me a lot more time

to sit with a table and listen to what they're doing, and decide, "Oh, wait, stop right here. Before you can do this, you need to do this."

RESEARCHER: I can't write fast enough!

MRS. HIDDLESTON: Sorry, I say all the words

RESEARCHER: No these are good words. This is good stuff. Okay, so quality and quantity differ. Let's talk about students providing quality feedback to each other. I know you can't hear it all the time because you're working with individuals, but what do you notice about the quality of feedback in traditional versus flipped between students.

MRS. HIDDLESTON: Again, lecture takes so long in traditional that they get very little time to talk with each other about the math. They're basically watching a guided practice happen and then they're trying it on their own, you know, so there's not a lot of time for them to discuss. But with the flipped classroom, the first thing we do is a quick hit of, "Here are the big things you should have learned from the video. Do you have any questions? Okay, go. Here's your activity for the day." And they're immediately talking about the math and having time to give each other feedback. And I like that with the flipped, I get to eavesdrop and hear, "Well I thought the video said this." Or "I thought we were supposed to do that." And then that's when I jump in, "Well okay, let's talk about that."

RESEARCHER: Lastly let's talk about delayed feedback. What happens when you delay feedback to students, either by design or because you were busy with other students?

MRS. HIDDLESTON: Delayed feedback in stats is bad because that means they are developing bad habits. Every stats unit or problem or type has a model; it has a method.

There's a process you have to go through to get to the bottom of the problem, and if I am not giving you feedback periodically then you're developing bad habits. You're skipping checking the assumptions or you're writing your parameters wrong. And if I haven't told you that, then you're just going to keep doing that wrong way over and over. It's going to become something you think is right. It's a bad habit and it's hard for me to break.

RESEARCHER: Do you feel like the students are able to give each other feedback on that kind of stuff?

MRS. HIDDLESTON: Once we get, you know the whole entire second semester is inference. And so those processes become a lot the same from unit to unit, maybe with different formulas, so once they've gotten comfortable with inference, they can. They can start to give each other feedback like, "Wait. No, you can't write it that way because this is a proportion, or these are means." But not immediately, no. They all have to learn the process initially, which is why that initial, right after the video, coming in and really learning the process is so valuable and why we need so much more class time to get that done.

RESEARCHER: Is there anything else about flipped classroom versus traditional classroom that you would like to share?

MRS. HIDDLESTON: My biggest challenge with flipped classroom, that I'm still working the bugs out of, is holding them accountable. What do I do if three people come in and they didn't do the video? What do I do if someone technically viewed the video, but they missed all the questions? Did you just play the video and randomly click things? I haven't been holding them accountable as far as taking grades for those because it's

always introducing something new. It's a new concept, and so I felt hesitant to say, "I'm going to grade you on something you've never seen before." But I'm trying to find a happy medium between not grading at all and grading accurately for every question. But I have to find some way to hold them accountable for preparing for class. I'm thinking possibly (I don't know if you need this in your audio recording or not), but I'm thinking about possibly doing the AP bucks or whatever like Heather and I think Kalea…

RESEARCHER: Yeah, I think they started it.

MRS. HIDDLESTON: Because I don't do, I know you do retakes, but I don't do retakes in stats. So, I was thinking about maybe letting them earn enough points to somehow get some points back on tests. I just, I don't know. I know Heather's AP Bucks has, "You can do a retake if you earn this many points," but I thought the rule was there are no retakes in AP.

RESEARCHER: Yeah, that's actually what the handbook says.

MRS. HIDDLESTON: So, I'm trying to balance that. I feel like I pretty fairly curve their scores already based on you only need a 70 to get a 5. If you get a 5, I'm thrilled. So, I don't know. I'm still thinking about that system.

RESEARCHER: Well, thank you for letting me interview you!

APPENDIX M

Feedback Data

Number of Feedback Interactions

POE 1	Date: 3-2-18			Date 3-8-18			Date 3-21-18		
	S	T	B	S	T	B	S	T	B
POE1_01	2	1	3	1	0	1	0	2	2
POE1_02	3	3	6	1	0	1	0	1	1
POE1_03	4	2	6	0	0	0	0	1	1
POE1_04	2	1	3	2	0	2	0	2	2
POE1_05	1	2	3	0	0	0	0	0	0
POE1_06	0	0	0	2	1	3	1	0	1
POE1_07	0	0	0	0	3	3	0	2	2
POE1_08	2	0	2	2	1	3	0	0	0
POE1_09	4	1	5	12	0	12	0	1	1
POE1_10	2	0	2	2	2	4	0	2	2
POE1_11	2	2	4	2	3	5	0	1	1
POE1_12	0	0	0	A	A	A	0	1	1
POE1_13	1	1	2	0	1	1	0	0	0
POE1_14	4	4	8	6	7	13	0	3	3
POE1_15	1	1	2	1	0	1	0	1	1
POE1_16	0	0	0	4	2	6	0	1	1
POE1_17	0	0	0	0	0	0	0	0	0

POE 1	Date 4-18-18			Date 4-20-18			Date 4-24-18		
	S	T	B	S	T	B	S	T	B
POE1_01	8	2	10	1	1	2	0	1	1
POE1_02	3	1	4	4	0	4	0	4	4
POE1_03	1	0	1	0	0	0	0	0	0
POE1_04	2	0	2	1	0	1	2	2	4
POE1_05	4	0	4	1	0	1	0	0	0
POE1_06	1	1	2	0	0	0	0	4	4
POE1_07	0	0	0	0	0	0	1	1	2
POE1_08	2	0	2	1	0	1	0	0	0
POE1_09	6	0	6	4	1	5	1	1	2
POE1_10	0	0	0	0	1	1	0	1	1
POE1_11	1	1	2	0	2	2	0	3	3
POE1_12	3	0	3	0	0	0	1	0	1
POE1_13	3	0	3	3	2	5	1	0	1
POE1_14	1	2	3	3	1	4	0	1	1
POE1_15	0	0	0	0	1	1	0	1	1
POE1_16	2	0	2	1	1	2	0	0	0

| POE1_17 | 9 | 0 | 9 | | 1 | 0 | 1 | | 5 | 0 | 5 |

Time of Feedback Interactions

POE 1	Date: 3-2-18			Date 3-8-18			Date 3-21-18		
	S	T	B	S	T	B	S	T	B
POE1_01	23	11	34	6	0	6	0	103	103
POE1_02	21	29	50	35	0	35	0	53	53
POE1_03	100	20	120	0	0	0	0	28	28
POE1_04	5	112	117	19	0	19	0	76	76
POE1_05	32	19	51	0	0	0	0	0	0
POE1_06	0	0	0	29	6	35	3	0	3
POE1_07	0	0	0	0	42	42	0	24	24
POE1_08	81	0	81	11	6	17	0	0	0
POE1_09	76	17	93	127	0	127	0	2	2
POE1_10	19	0	19	22	31	53	0	21	21
POE1_11	66	102	168	25	54	79	0	7	7
POE1_12	0	0	0	A	A	A	0	5	5
POE1_13	5	12	17	0	13	13	0	0	0
POE1_14	45	144	189	97	217	314	0	24	24
POE1_15	60	3	63	2	0	2	0	16	16
POE1_16	0	0	0	43	56	99	0	6	6
POE1_17	0	0	0	0	0	0	0	0	0

POE 1	Date 4-18-18			Date 4-20-18			Date 4-24-18		
	S	T	B	S	T	B	S	T	B
POE1_01	295	60	355	32	22	54	0	28	28
POE1_02	38	2	40	44	0	44	0	111	111
POE1_03	2	0	2	0	0	0	0	0	0
POE1_04	102	0	102	108	0	108	9	126	135
POE1_05	27	0	27	3	0	3	0	0	0
POE1_06	36	4	40	0	0	0	0	173	173
POE1_07	0	0	0	0	0	0	27	4	31
POE1_08	58	0	58	7	0	7	0	0	0
POE1_09	68	0	68	98	30	128	6	67	73
POE1_10	0	0	0	0	30	30	0	6	6
POE1_11	10	86	96	0	210	210	0	84	84
POE1_12	30	0	30	0	0	0	17	0	17
POE1_13	23	0	23	104	6	110	24	0	24
POE1_14	32	40	72	52	1	53	0	28	28
POE1_15	0	0	0	0	4	4	0	60	60
POE1_16	60	0	60	5	34	39	0	0	0
POE1_17	92	0	92	25	0	25	102	0	102

Number of Feedback Interactions

POE 2	Date: 3-2-18			Date 3-6-18			Date 3-21-18		
	S	T	B	S	T	B	S	T	B
POE2_01	A	A	A	8	2	10	1	1	2
POE2_02	0	0	0	0	2	2	0	1	1
POE2_03	2	0	2	1	5	6	1	1	2
POE2_04	0	0	0	7	2	9	2	2	4
POE2_05	1	0	1	2	3	5	1	0	1
POE2_06	0	0	0	0	3	3	0	6	6
POE2_07	0	0	0	1	2	3	3	2	5
POE2_08	0	2	2	1	0	1	0	0	0
POE2_09	0	0	0	1	4	5	0	1	1
POE2_10	1	0	1	5	2	7	2	1	3
POE2_11	A	A	A	4	1	5	1	1	2
POE2_12	0	3	3	3	1	4	4	1	5
POE2_13	0	0	0	7	1	8	0	0	0
POE2_14	1	1	2	9	2	11	8	2	10

POE 2	Date 4-6-18			Date 4-20-18			Date 4-24-18		
	S	T	B	S	T	B	S	T	B
POE2_01	0	0	0	A	A	A	0	0	0
POE2_02	0	0	0	5	0	5	0	0	0
POE2_03	0	0	0	1	1	2	A	A	A
POE2_04	0	0	0	3	0	3	0	0	0
POE2_05	0	0	0	0	0	0	0	0	0
POE2_06	0	0	0	0	4	4	0	0	0
POE2_07	0	0	0	0	0	0	0	0	0
POE2_08	0	0	0	0	1	1	0	0	0
POE2_09	A	A	A	0	0	0	0	0	0
POE2_10	0	0	0	3	0	3	0	0	0
POE2_11	1	0	1	1	0	1	0	0	0
POE2_12	0	0	0	3	1	4	0	2	2
POE2_13	0	0	0	3	0	3	1	1	2
POE2_14	0	0	0	2	0	2	0	0	0

Time of Feedback Interactions

POE 2	Date: 3-2-18			Date 3-6-18			Date 3-21-18		
	S	T	B	S	T	B	S	T	B
POE2_01	A	A	A	181	192	373	4	11	15
POE2_02	0	0	0	0	192	192	0	9	9
POE2_03	27	0	27	5	78	83	6	13	19
POE2_04	0	0	0	150	192	342	16	81	97
POE2_05	38	0	38	14	68	82	28	0	28
POE2_06	0	0	0	0	206	206	0	97	97
POE2_07	0	0	0	12	72	84	19	32	51
POE2_08	0	56	56	39	0	39	0	0	0
POE2_09	0	0	0	39	109	148	0	12	12
POE2_10	17	0	17	296	131	427	54	18	72
POE2_11	A	A	A	138	20	158	34	111	145
POE2_12	0	60	60	82	44	126	91	18	109
POE2_13	0	0	0	273	20	293	0	0	0
POE2_14	3	9	12	439	128	567	145	48	193

POE 2	Date 4-6-18			Date 4-20-18			Date 4-24-18		
	S	T	B	S	T	B	S	T	B
POE2_01	0	0	0	A	A	A	0	0	0
POE2_02	0	0	0	77	0	77	0	0	0
POE2_03	0	0	0	33	12	45	A	A	A
POE2_04	0	0	0	85	0	85	0	0	0
POE2_05	0	0	0	0	0	0	0	0	0
POE2_06	0	0	0	0	141	141	0	0	0
POE2_07	0	0	0	0	0	0	0	0	0
POE2_08	0	0	0	0	22	22	0	0	0
POE2_09	A	A	A	0	0	0	0	0	0
POE2_10	0	0	0	46	0	46	0	0	0
POE2_11	14	0	14	27	0	27	0	0	0
POE2_12	0	0	0	147	25	172	0	11	11
POE2_13	0	0	0	127	0	127	5	20	25
POE2_14	0	0	0	22	0	22	0	0	0

AP Statistics	Number			Time		
	S	T	B	S	T	B
Stats_01	2	2	4	51	200	251
Stats_02	2	1	3	38	15	53
Stats_03	5	1	6	68	69	137
Stats_04	5	0	5	51	0	51
Stats_05	0	5	5	0	411	411
Stats_06	2	4	6	81	397	478
Stats_07	1	1	2	34	149	183
Stats_08	3	0	3	25	0	25
Stats_09	4	3	7	171	230	401
Stats_10	4	4	8	68	254	322
Stats_11	5	3	8	49	156	205

Note. Time is measured in seconds. S = Student
interactions. T = teacher interactions. B = sum of student
and teacher interactions.

APPENDIX N

Survey Open-Response Answers

Instructional Preference	Student Responses
Traditional	It is the teachers' job to teach. Teachers get paid to educate their students during school hours, not to send home educational videos to do out of school hours. You cannot change my mind.
Traditional	I like being able to ask questions, but I still understand learning at home since there is not enough time in class.
Depends on the lesson	Sometimes a certain lesson is harder, so I need more teacher instruction.
Depends on the lesson	Sometimes, flipped classrooms allows us to go at a faster pace. Working practice problems with a teacher working it with us makes sure that we understand thoroughly.
Flipped	I prefer Flipped Classroom from its convenience.
Flipped	It's nice just doing the learning out of class and getting the boring stuff out of the way first. Then, when we get into class, we can spend more time ironing things out that we don't know and doing more application type problems instead of just listening to the teacher lecture for an hour and a half.
Traditional	I can't usually understand the material if I have to teach it to myself. It is much easier for me to have someone available to ask questions and get explanations from while I'm learning.
Traditional	Easier for me to learn.
Depends on the lesson	(Student provided no response)
Traditional	I learn by taking notes which I like to do in the classroom
No preference	Cause I have no preference
Traditional	I learn better in class when the teacher teaches everything. That way I can complete work for homework and come into zero block the next morning if I don't understand.

Traditional	because if I'm confused I can just ask a question right then instead of having to wait until the next day.
Depends on the lesson	I prefer it when the teacher can explain something that students don't understand, and I don't like having a grade on Edpuzzles. However, if class time can be spent on other things, it isn't that important.
Depends on the lesson	I like the traditional classroom better when the class is smaller. The flipped classroom is almost like we're learning at home and doing the work at the school which is good for some lessons but not all.
Depends on the lesson	Some lessons were better for flipped classroom because I could go at my own pace.
Traditional	I HATE ED PUZZLES. I can't really learn from them, and I always stress about making a good grade or getting them all right. I would do Edpuzzles to save time, but I learn better with traditional learning.
Depends on the lesson	Because sometimes, it's better for me to have the teacher right in front of me explaining everything so if I have questions is can ask them right away. Other lessons, I understand, and I can just do it as homework.
Flipped	The Flipped Classroom model has students learn lessons at home. This allows students to receive more in-depth help during the school day and I think it's great. Doing what would have been homework during class supports the student by letting the student ask for help for harder work (if that makes sense). Of course, there will be students that won't listen to/watch the lesson, but this is also true about homework in the traditional setting. This is the biggest downside of the flipped model because, if a student doesn't watch the lesson, they won't know what the next class will be about and this hinders everyone in the class from properly learning the necessary material. But for the people that do watch the lessons at home, the flipped model is very beneficial and aids in understanding the unit, and as I've found during your study, I make better grades using the flipped model, so that's always a plus.
Traditional	I like being able to learn with the help of the teacher during school, where I can ask questions and better understand the topics being covered. My preference is highly dependent on the actions of others, not just my opinion. The flipped setting allows me to really think about the lesson and come up with questions to ask the

teacher in the next class. However, the flipped classroom would be detrimental if the instructional lesson were to become coherently difficult to follow: if there were questions asked about the topic before the topic was properly instructed. Which in some cases it has (primarily in another class). Another reason I have the preference for the traditional classroom is based on my schedule. Sometimes I do not have enough time in the day (with all of the work in my other classes piling up) to learn a new unit on my own.

Flipped	It allows me to learn at my own pace. If I am confused on something I can simply rewind the video and listen to it again. You can't rewind time (yet).
Depends on the lesson	If it is something completely new, it would be better for the teacher to use the traditional classroom. If it is something simple and not too complicated, flipped is okay.
Traditional	I prefer an interactive lesson where I can answer questions out loud and ask questions instead of googling them.
Flipped	It's just so we can do the bulk of the math in class. Also, if I need to look back onto something or need help I could just look at the Edpuzzle.
Traditional	I can ask specific questions to the teacher if I don't understand what we're learning. When it is on an Edpuzzle you can't ask questions.
Traditional	I need to see something be done step by step and be able to ask questions to understand something.
Depends on the lesson	Some lessons are harder than others.
Traditional	I like this because I can ask questions and be more interactive to help me understand the subject more.
Traditional	Because it had a more personal touch.
Traditional	No interaction with video. Don't learn as well.
No preference	I feel that both methods of teaching are effective.

Addendum: Questions from Principles of Engineering's Survey 1

Feedback on Edpuzzle

I'm going to ask you a series of questions about the questions within the Edpuzzle. I want to know if you are getting good feedback from those questions, i.e. do the questions help you understand the concepts you are supposed to learn. When I ask you if a question "helped you learn," I'm asking if attempting the question and finding out if your answer was correct was helpful information in your learning journey. All questions are optional.

Question 1

Please answer the questions below about question 1 on the Edpuzzle.

This was question 1.

Why do we keep the golden screws separated from the black screws?

☐ They are actually made of gold.

incorrect

☐ They have a different diameter.

correct

☐ Just to be difficult.

incorrect

☐ Like two beta fish in the same bowl, they will fight if placed in the same bin.

incorrect

1. **Did attempting this question and finding out whether you were correct help you learn?**
   Mark only one oval.

   ◯ Yes

   ◯ No

   ◯ I don't remember.

2. Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.
Check all that apply.

☐ Yes; I rewatched a section of the video.

☐ Yes; I looked up information on the internet or in a book.

☐ Yes; I asked for help from a teacher, friend, or family member.

☐ Yes; I did something other than the options above.

☐ No.

☐ I don't remember.

☐ Other: _____

3. Did you do anything AFTER you found out if you were correct or not? Select all that apply.
Check all that apply.

☐ Yes; I wrote down the problem or something about the problem in my notes.

☐ Yes; I asked a friend or family member for help.

☐ Yes; I emailed my teacher for help.

☐ Yes; I plan to ask my teacher for help in class.

☐ Yes; I looked up more information in a book or on the internet.

☐ Yes; I tried to figure out what I did wrong without using outside sources.

☐ No.

☐ I don't remember.

☐ Other: _____

Question 2
Please answer the questions below about question 2 on the Edpuzzle.

This was question 2.

Which of the following are digital sensors? Mark all that apply.

☐ Potentiometer

incorrect

☐ Optical Shaft Encoder

correct

☐ Limit Switch

correct

☐ Bump Switch

correct

4. Did attempting this question and finding out whether you were correct help you learn?
Mark only one oval.

○ Yes

○ No

○ I don't remember.

5. Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.
Check all that apply.

☐ Yes; I rewatched a section of the video.

☐ Yes; I looked up information on the internet or in a book.

☐ Yes; I asked for help from a teacher, friend, or family member.

☐ Yes; I did something other than the options above.

☐ No.

☐ I don't remember.

☐ Other: _____

6. Did you do anything AFTER you found out if you were correct or not? Select all that apply.
Check all that apply.

☐ Yes; I wrote down the problem or something about the problem in my notes.

☐ Yes; I asked a friend or family member for help.

☐ Yes; I emailed my teacher for help.

☐ Yes; I plan to ask my teacher for help in class.

☐ Yes; I looked up more information in a book or on the internet.

☐ Yes; I tried to figure out what I did wrong without using outside sources.

☐ No.

☐ I don't remember.

☐ Other: _____

Question 3

Please answer the questions below about question 3 on the Edpuzzle.

This is question 3.

The difference between digital and analog sensors is important for many reasons. For right now, we need to know whether a sensor is digital or analog in order to....

☐ acurately graph the inputs with respect to time while using the sensor.

<div align="right">incorrect</div>

☐ place it in the correct port on the cortex.

<div align="right">correct</div>

☐ place it in the correct bin of the VEX toolbox.

<div align="right">incorrect</div>

☐ determine whether it prefers chocolate or vanilla ice cream.

<div align="right">incorrect</div>

7. **Did attempting this question and finding out whether you were correct help you learn?**
   Mark only one oval.

   ◯ Yes
   ◯ No
   ◯ I don't remember.

8. **Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.**
   Check all that apply.

   ☐ Yes; I rewatched a section of the video.
   ☐ Yes; I looked up information on the internet or in a book.
   ☐ Yes; I asked for help from a teacher, friend, or family member.
   ☐ Yes; I did something other than the options above.
   ☐ No.
   ☐ I don't remember.
   ☐ Other: _____

9. Did you do anything AFTER you found out if you were correct or not? Select all that apply.
Check all that apply.

- [ ] Yes; I wrote down the problem or something about the problem in my notes.
- [ ] Yes; I asked a friend or family member for help.
- [ ] Yes; I emailed my teacher for help.
- [ ] Yes; I plan to ask my teacher for help in class.
- [ ] Yes; I looked up more information in a book or on the internet.
- [ ] Yes; I tried to figure out what I did wrong without using outside sources.
- [ ] No.
- [ ] I don't remember.
- [ ] Other: _____

Question 5

Please answer the questions below about question 5 on the Edpuzzle.

This is question 5.

Which sensor counts?

- [ ] Bump Switch

  incorrect

- [ ] Sonar (Ultrasonic Range Finder)

  incorrect

- [ ] Encode

  correct

- [ ] Limit Switch

  incorrect

10. Did attempting this question and finding out whether you were correct help you learn?
Mark only one oval.

- ( ) Yes
- ( ) No
- ( ) I don't remember.

11. Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.

Check all that apply.

☐ Yes; I rewatched a section of the video.

☐ Yes; I looked up information on the internet or in a book.

☐ Yes; I asked for help from a teacher, friend, or family member.

☐ Yes; I did something other than the options above.

☐ No.

☐ I don't remember.

☐ Other: _____

12. Did you do anything AFTER you found out if you were correct or not? Select all that apply.

Check all that apply.

☐ Yes; I wrote down the problem or something about the problem in my notes.

☐ Yes; I asked a friend or family member for help.

☐ Yes; I emailed my teacher for help.

☐ Yes; I plan to ask my teacher for help in class.

☐ Yes; I looked up more information in a book or on the internet.

☐ Yes; I tried to figure out what I did wrong without using outside sources.

☐ No.

☐ I don't remember.

☐ Other: _____

Question 6

Please answer the questions below about question 6 on the Edpuzzle.

This is question 6.

Which sensors can be plugged into the analog ports? Mark all that apply

☐ Potentiometer

correct

☐ Light Sensor

correct

☐ Line Follower

correct

☐ Sonar (Ultrasonic Range Finder)

incorrect

☐ Encoder

incorrect

13. **Did attempting this question and finding out whether you were correct help you learn?**
Mark only one oval.

◯ Yes

◯ No

◯ I don't remember.

14. **Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.**
Check all that apply.

☐ Yes; I rewatched a section of the video.

☐ Yes; I looked up information on the internet or in a book.

☐ Yes; I asked for help from a teacher, friend, or family member.

☐ Yes; I did something other than the options above.

☐ No.

☐ I don't remember.

☐ Other: _____

15. **Did you do anything AFTER you found out if you were correct or not? Select all that apply.**
    Check all that apply.

    ☐ Yes; I wrote down the problem or something about the problem in my notes.

    ☐ Yes; I asked a friend or family member for help.

    ☐ Yes; I emailed my teacher for help.

    ☐ Yes; I plan to ask my teacher for help in class.

    ☐ Yes; I looked up more information in a book or on the internet.

    ☐ Yes; I tried to figure out what I did wrong without using outside sources.

    ☐ No.

    ☐ I don't remember.

    ☐ Other: _____

Question 7
Please answer the questions below about question 7 on the Edpuzzle.

This is question 7.

> Now imagine the servo is connected to the larger, 60 tooth, gear and it moves through an angle of 90°. Through how many degrees will the 36-tooth gear turn?

☐ 200

incorrect

☐ 60

incorrect

☐ 54

incorrect

☐ 150

correct

16. **Did attempting this question and finding out whether you were correct help you learn?**
    Mark only one oval.

    ◯ Yes

    ◯ No

    ◯ I don't remember.

17. Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.

Check all that apply.

☐ Yes; I rewatched a section of the video.

☐ Yes; I looked up information on the internet or in a book.

☐ Yes; I asked for help from a teacher, friend, or family member.

☐ Yes; I did something other than the options above.

☐ No.

☐ I don't remember.

☐ Other: _____

18. Did you do anything AFTER you found out if you were correct or not? Select all that apply.

Check all that apply.

☐ Yes; I wrote down the problem or something about the problem in my notes.

☐ Yes; I asked a friend or family member for help.

☐ Yes; I emailed my teacher for help.

☐ Yes; I plan to ask my teacher for help in class.

☐ Yes; I looked up more information in a book or on the internet.

☐ Yes; I tried to figure out what I did wrong without using outside sources.

☐ No.

☐ I don't remember.

☐ Other: _____

Addendum: Questions from Digital Electronics' Survey 1

Feedback on Edpuzzle

I'm going to ask you a series of questions about the questions within the Edpuzzle. I want to know if you are getting good feedback from those questions, i.e. do the questions help you understand the concepts you are supposed to learn. When I ask you if a question "helped you learn," I'm asking if attempting the question and finding out if your answer was correct was helpful information in your learning journey. All questions are optional.

Question 1
Please answer the questions below about question 1 on the Edpuzzle.

This was question 1.

> Why do you think humans are so fond of the base 10 system?

1. Did attempting this question and finding out whether you were correct help you learn?
Mark only one oval.

◯ Yes

◯ No

◯ I don't remember.

2. Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.
Check all that apply.

☐ Yes; I rewatched a section of the video.

☐ Yes; I looked up information on the internet or in a book.

☐ Yes; I asked for help from a teacher, friend, or family member.

☐ Yes; I did something other than the options above.

☐ No.

☐ I don't remember.

☐ Other: _____

3. **Did you do anything AFTER you found out if you were correct or not? Select all that apply.**
Check all that apply.

☐ Yes; I wrote down the problem or something about the problem in my notes.

☐ Yes; I asked a friend or family member for help.

☐ Yes; I emailed my teacher for help.

☐ Yes; I plan to ask my teacher for help in class.

☐ Yes; I looked up more information in a book or on the internet.

☐ Yes; I tried to figure out what I did wrong without using outside sources.

☐ No.

☐ I don't remember.

☐ Other: _____

Question 2
Please answer the questions below about question 2 on the Edpuzzle.

This was question 2.

Why do you think computers use a base 2 system?

4. **Did attempting this question and finding out whether you were correct help you learn?**
Mark only one oval.

◯ Yes

◯ No

◯ I don't remember.

5. **Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.**
Check all that apply.

☐ Yes; I rewatched a section of the video.

☐ Yes; I looked up information on the internet or in a book.

☐ Yes; I asked for help from a teacher, friend, or family member.

☐ Yes; I did something other than the options above.

☐ No.

☐ I don't remember.

☐ Other: _____

6. **Did you do anything AFTER you found out if you were correct or not? Select all that apply.**
   Check all that apply.

   ☐ Yes; I wrote down the problem or something about the problem in my notes.

   ☐ Yes; I asked a friend or family member for help.

   ☐ Yes; I emailed my teacher for help.

   ☐ Yes; I plan to ask my teacher for help in class.

   ☐ Yes; I looked up more information in a book or on the internet.

   ☐ Yes; I tried to figure out what I did wrong without using outside sources.

   ☐ No.

   ☐ I don't remember.

   ☐ Other: _____

Question 3
Please answer the questions below about question 3 on the Edpuzzle.

This is question 3.

> Can you think of a modern application of the base 60 system?

7. **Did attempting this question and finding out whether you were correct help you learn?**
   Mark only one oval.

   ◯ Yes

   ◯ No

   ◯ I don't remember.

8. **Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.**
   Check all that apply.

   ☐ Yes; I rewatched a section of the video.

   ☐ Yes; I looked up information on the internet or in a book.

   ☐ Yes; I asked for help from a teacher, friend, or family member.

   ☐ Yes; I did something other than the options above.

   ☐ No.

   ☐ I don't remember.

   ☐ Other: _____

9. **Did you do anything AFTER you found out if you were correct or not? Select all that apply.**
   Check all that apply.

   ☐ Yes; I wrote down the problem or something about the problem in my notes.

   ☐ Yes; I asked a friend or family member for help.

   ☐ Yes; I emailed my teacher for help.

   ☐ Yes; I plan to ask my teacher for help in class.

   ☐ Yes; I looked up more information in a book or on the internet.

   ☐ Yes; I tried to figure out what I did wrong without using outside sources.

   ☐ No.

   ☐ I don't remember.

   ☐ Other: _____

Question 4
Please answer the questions below about question 4 on the Edpuzzle.

This is question 4.

Write 100_{10} in binary.
☐ 1101110_2
incorrect
☐ 01110011_2
incorrect
☐ 1100100_2
correct
☐ 100_2
incorrect

10. **Did attempting this question and finding out whether you were correct help you learn?**
    Mark only one oval.

    ◯ Yes

    ◯ No

    ◯ I don't remember.

11. Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.
Check all that apply.

- ☐ Yes; I rewatched a section of the video.
- ☐ Yes; I looked up information on the internet or in a book.
- ☐ Yes; I asked for help from a teacher, friend, or family member.
- ☐ Yes; I did something other than the options above.
- ☐ No.
- ☐ I don't remember.
- ☐ Other: _____

12. Did you do anything AFTER you found out if you were correct or not? Select all that apply.
Check all that apply.

- ☐ Yes; I wrote down the problem or something about the problem in my notes.
- ☐ Yes; I asked a friend or family member for help.
- ☐ Yes; I emailed my teacher for help.
- ☐ Yes; I plan to ask my teacher for help in class.
- ☐ Yes; I looked up more information in a book or on the internet.
- ☐ Yes; I tried to figure out what I did wrong without using outside sources.
- ☐ No.
- ☐ I don't remember.
- ☐ Other: _____

Question 5
Please answer the questions below about question 5 on the Edpuzzle.

This is question 5.

What is 01110011_2 in decimal?

- ☐ 230_{10} incorrect
- ☐ $1,110,011_{10}$ incorrect
- ☐ 115_{10} correct
- ☐ 140_{10} incorrect

13. **Did attempting this question and finding out whether you were correct help you learn?**
    Mark only one oval.

    ◯ Yes

    ◯ No

    ◯ I don't remember.

14. **Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.**
    Check all that apply.

    ☐ Yes; I rewatched a section of the video.

    ☐ Yes; I looked up information on the internet or in a book.

    ☐ Yes; I asked for help from a teacher, friend, or family member.

    ☐ Yes; I did something other than the options above.

    ☐ No.

    ☐ I don't remember.

    ☐ Other: _____

15. **Did you do anything AFTER you found out if you were correct or not? Select all that apply.**
    Check all that apply.

    ☐ Yes; I wrote down the problem or something about the problem in my notes.

    ☐ Yes; I asked a friend or family member for help.

    ☐ Yes; I emailed my teacher for help.

    ☐ Yes; I plan to ask my teacher for help in class.

    ☐ Yes; I looked up more information in a book or on the internet.

    ☐ Yes; I tried to figure out what I did wrong without using outside sources.

    ☐ No.

    ☐ I don't remember.

    ☐ Other: _____

Question 6
Please answer the questions below about question 6 on the Edpuzzle.

This is question 6.

Convert 156_{16} to decimal.

☐ $9C_{10}$

<div align="right">incorrect</div>

☐ 342_{10}

<div align="right">correct</div>

☐ 156_{10}

<div align="right">incorrect</div>

☐ 10011100_{10}

<div align="right">incorrect</div>

16. **Did attempting this question and finding out whether you were correct help you learn?**
    Mark only one oval.

    ◯ Yes

    ◯ No

    ◯ I don't remember.

17. **Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.**
    Check all that apply.

    ☐ Yes; I rewatched a section of the video.

    ☐ Yes; I looked up information on the internet or in a book.

    ☐ Yes; I asked for help from a teacher, friend, or family member.

    ☐ Yes; I did something other than the options above.

    ☐ No.

    ☐ I don't remember.

    ☐ Other: _____

18. **Did you do anything AFTER you found out if you were correct or not? Select all that apply.**
    Check all that apply.

    ☐ Yes; I wrote down the problem or something about the problem in my notes.

    ☐ Yes; I asked a friend or family member for help.

    ☐ Yes; I emailed my teacher for help.

    ☐ Yes; I plan to ask my teacher for help in class.

    ☐ Yes; I looked up more information in a book or on the internet.

    ☐ Yes; I tried to figure out what I did wrong without using outside sources.

    ☐ No.

    ☐ I don't remember.

    ☐ Other: _____

APPENDIX Q

Addendum: Survey 1 Responses from Principles of Engineering

Did attempting this question and finding out whether you were correct help you learn?	**Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.**	**Did you do anything AFTER you found out if you were correct or not? Select all that apply.**
Question 1		
No	No.	No.
Yes	No.	No.
No	No.	No.
No	No.	No.
Yes	Yes; I rewatched a section of the video.	No.
Yes	No.	No.
No	No.	Yes; I plan to ask my teacher for help in class.
Yes	Yes; I rewatched a section of the video.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	Yes; I rewatched a section of the video., Yes; I looked up information on the internet or in a book.	Yes; I wrote down the problem or something about the problem in my notes., Yes; I looked up more information in a book or on the internet.
Yes	No.	No.
Yes	Yes; I rewatched a section of the video.	No.
No	No.	No.
Yes	Yes; I rewatched a section of the video., Yes; I looked up information on the internet or in a book.	Yes; I looked up more information in a book or on the internet., Yes; I tried to figure out what I did wrong without using outside sources.

| Yes | Yes; I rewatched a section of the video., Yes; I asked for help from a teacher, friend, or family member. | Yes; I wrote down the problem or something about the problem in my notes. |

Question 2

No	Yes; I did something other than the options above., Looked at notes I was writing for answer(s)	No.
Yes	No.	No.
No	Yes; I rewatched a section of the video.	No.
Yes	Yes; I rewatched a section of the video.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	Yes; I rewatched a section of the video.	No.
Yes	No.	No.
Yes	Yes; I rewatched a section of the video.	Yes; I plan to ask my teacher for help in class.
Yes	Yes; I rewatched a section of the video.	Yes; I looked up more information in a book or on the internet.
Yes	Yes; I rewatched a section of the video., Yes; I asked for help from a teacher, friend, or family member.	Yes; I looked up more information in a book or on the internet.
Yes	No.	Yes; I plan to ask my teacher for help in class., Yes; I tried to figure out what I did wrong without using outside sources.
Yes	Yes; I rewatched a section of the video.	No.
Yes	No.	No.
Yes	Yes; I rewatched a section of the video.	Yes; I tried to figure out what I did wrong without using outside sources.
Yes	Yes; I rewatched a section of the video., Yes; I asked for help from a teacher, friend, or family member.	Yes; I wrote down the problem or something about the problem in my notes.

Question 3

Yes	No.	Yes; I tried to figure out what I did wrong without using outside sources.
Yes	No.	No.
No	No.	No.
Yes	Yes; I rewatched a section of the video.	No.
Yes	Yes; I rewatched a section of the video.	No.
Yes	No.	Yes; I looked up more information in a book or on the internet.
Yes	Yes; I rewatched a section of the video.	Yes; I plan to ask my teacher for help in class.
Yes	Yes; I rewatched a section of the video.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	Yes; I rewatched a section of the video.	Yes; I asked a friend or family member for help., I asked my teacher in person
Yes	No.	Yes; I plan to ask my teacher for help in class., Yes; I tried to figure out what I did wrong without using outside sources., I also rewatched this section of the video.
Yes	No.	No.
Yes	No.	No.
I don't remember.	Yes; I rewatched a section of the video., Yes; I looked up information on the internet or in a book.	No.
Yes	Yes; I rewatched a section of the video., Yes; I asked for help from a teacher, friend, or family member.	Yes; I wrote down the problem or something about the problem in my notes.

Question 4

Yes	Yes; I did something other than the options above., Looked at notes I was writing.	No.
Yes	No.	No.

Yes	Yes; I rewatched a section of the video., Yes; I looked up information on the internet or in a book.	No.
Yes	No.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	Yes; I rewatched a section of the video.	No.
Yes	No.	No.
Yes	Yes; I rewatched a section of the video.	Yes; I plan to ask my teacher for help in class.
Yes	Yes; I rewatched a section of the video.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	Yes; I rewatched a section of the video., Yes; I asked for help from a teacher, friend, or family member.	Yes; I asked a friend or family member for help.
Yes	Yes; I rewatched a section of the video.	Yes; I tried to figure out what I did wrong without using outside sources.
Yes	No.	No.
Yes	No.	No.
Yes	Yes; I rewatched a section of the video., Yes; I looked up information on the internet or in a book.	Yes; I looked up more information in a book or on the internet.
Yes	Yes; I rewatched a section of the video., Yes; I looked up information on the internet or in a book.	Yes; I wrote down the problem or something about the problem in my notes., No.

Question 5

No	Yes; I did something other than the options above., Looked at notes I was writing.	No.
Yes	Yes; I rewatched a section of the video.	No.
Yes	Yes; I rewatched a section of the video., Yes; I looked up information on the internet or in a book.	No.

Yes	Yes; I did something other than the options above., I have notes on the types of sensors.	No.
Yes	Yes; I rewatched a section of the video.	No.
Yes	No.	No.
Yes	Yes; I rewatched a section of the video.	Yes; I plan to ask my teacher for help in class.
Yes	Yes; I rewatched a section of the video.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	Yes; I rewatched a section of the video.	Yes; I asked a friend or family member for help.
Yes	Yes; I rewatched a section of the video.	No.
Yes	Yes; I rewatched a section of the video.	No.
Yes	No.	looked back over the digital and analog sensors
Yes	Yes; I rewatched a section of the video.	Yes; I looked up more information in a book or on the internet., Yes; I tried to figure out what I did wrong without using outside sources.
Yes	Yes; I rewatched a section of the video.	No.

Question 6

Yes	No.	No., I already had stuff pertaining to the problem in my notes.
Yes	No.	Yes; I tried to figure out what I did wrong without using outside sources.
Yes	Yes; I did something other than the options above.	No.
Yes	No.	No.
Yes	No.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	No.	No.
Yes	No.	No.
Yes	Yes; I rewatched a section of the video.	

Yes	Yes; I rewatched a section of the video.	Yes; I asked a friend or family member for help.
Yes	Yes; I rewatched a section of the video.	No.
Yes	I tried to use the formula it paused on.	No.
Yes	used ti nspire to do the math	No.
Yes	Yes; I did something other than the options above.	Yes; I wrote down the problem or something about the problem in my notes., Yes; I tried to figure out what I did wrong without using outside sources.
Yes	Yes; I rewatched a section of the video.	Yes; I wrote down the problem or something about the problem in my notes.

APPENDIX R

Addendum: Survey 1 Responses from Digital Electronics

Did attempting this question and finding out whether you were correct help you learn?	Did you do anything BEFORE you selected an answer to better answer this question? Select all that apply.	Did you do anything AFTER you found out if you were correct or not? Select all that apply.
Question 1		
Yes	No.	No.
Yes	Yes; I looked up information on the internet or in a book.	Yes; I looked up more information in a book or on the internet.
Yes	No.	No.
Yes	No.	No.
Yes	No.	No.
No	Yes; I asked for help from a teacher, friend, or family member.	Yes; I looked up more information in a book or on the internet.
Yes	Yes; I looked up information on the internet or in a book.	Yes; I looked up more information in a book or on the internet.
Yes	Yes; I looked up information on the internet or in a book.	Yes; I tried to figure out what I did wrong without using outside sources.
I don't remember.	No.	No.
Yes	Yes; I rewatched a section of the video.	No.
Yes	Yes; I looked up information on the internet or in a book.	No.
Yes	Yes; I looked up information on the internet or in a book.	Yes; I asked a friend or family member for help.
Yes	No.	Yes; I tried to figure out what I did wrong without using outside sources.
Yes	Yes; I asked for help from a teacher, friend, or family member.	No.

I don't remember.	I don't remember.	I don't remember.
Yes	Yes; I did something other than the options above.	I did a little victory dance
Yes	No.	Yes; I tried to figure out what I did wrong without using outside sources.

Question 2

Yes	No.	No.
Yes	Yes; I looked up information on the internet or in a book.	Yes; I looked up more information in a book or on the internet.
Yes	No.	No.
Yes	No.	No.
Yes	No.	No.
No	I don't remember.	I don't remember.
Yes	Yes; I looked up information on the internet or in a book.	No.
Yes	Yes; I looked up information on the internet or in a book.	Yes; I looked up more information in a book or on the internet.
No	No.	No.
Yes	No.	No.
Yes	No.	No.
Yes	No.	Yes; I tried to figure out what I did wrong without using outside sources.
Yes	No.	I kind of already new why they used a different number system so it just reinforced my previous knowledge on the matter
Yes	Yes; I asked for help from a teacher, friend, or family member.	No.
I don't remember.	I don't remember.	I don't remember.
Yes	Yes; I did something other than the options above.	evaluated how I got it right
Yes	No.	Yes; I tried to figure out what I did wrong without using outside sources.

Question 3

Yes	No.	No.

Yes	Yes; I looked up information on the internet or in a book.	Yes; I looked up more information in a book or on the internet.
No	Yes; I looked up information on the internet or in a book.	No.
No	No.	No.
Yes	No.	No.
I don't remember.	I don't remember.	I don't remember.
Yes	Yes; I looked up information on the internet or in a book.	No.
Yes	Yes; I looked up information on the internet or in a book.	Yes; I looked up more information in a book or on the internet.
No	No.	No.
Yes	No.	No.
Yes	No.	No.
Yes	Yes; I looked up information on the internet or in a book.	Yes; I looked up more information in a book or on the internet.
Yes	No.	I haven't found out if I was correct yet because you told us to ask you in class tomorrow
Yes	No.	No.
I don't remember.	I don't remember.	I don't remember.
Yes	Yes; I rewatched a section of the video.	Yes; I asked a friend or family member for help.
No	No.	No.

Question 4

Yes	No.	No.
Yes	Yes; I rewatched a section of the video.	Yes; I looked up more information in a book or on the internet., Yes; I tried to figure out what I did wrong without using outside sources.
Yes	No.	No.
Yes	No.	Yes; I looked up more information in a book or on the internet.
Yes	Yes; I rewatched a section of the video.	No.
Yes	Yes; I asked for help from a teacher, friend, or family member.	I don't remember.
Yes	No.	No.
Yes	Yes; I looked up information on the internet or in a book.	No.

Yes	No.	No.
Yes	No.	No.
Yes	No.	No.
Yes	Yes; I rewatched a section of the video.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	No.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	Yes; I asked for help from a teacher, friend, or family member.	Yes; I wrote down the problem or something about the problem in my notes.
I don't remember.	I don't remember.	I don't remember.
Yes	Yes; I did something other than the options above.	No.
Yes	Yes; I did something other than the options above., I worked the problem how the instructor explained to work it	No.

Question 5

Yes	No.	Reattempted the problem
Yes	Yes; I rewatched a section of the video., Yes; I did something other than the options above.	I kept watching the Edpuzzle
No	No.	No.
Yes	No.	No.
Yes	Yes; I rewatched a section of the video.	No.
Yes	Yes; I asked for help from a teacher, friend, or family member.	I don't remember.
Yes	No.	No.
Yes	Yes; I looked up information on the internet or in a book.	No.
Yes	No.	No.
Yes	No.	No.
Yes	No.	No.
Yes	Yes; I asked for help from a teacher, friend, or family member.	Yes; I asked a friend or family member for help.
Yes	No.	Yes; I wrote down the problem or something about the problem in my notes.

Yes	No.	Yes; I wrote down the problem or something about the problem in my notes.
I don't remember.	I don't remember.	I don't remember.
Yes	Yes; I rewatched a section of the video.	No.
Yes	Yes; I did something other than the options above., I worked the problem	No.

Question 6

Yes	No.	No.
Yes	Yes; I rewatched a section of the video., Yes; I did something other than the options above.	No., I kept watching the Edpuzzle.
Yes	No.	No.
Yes	Yes; I rewatched a section of the video.	No.
Yes	Yes; I rewatched a section of the video.	No.
I don't remember.	I don't remember.	I don't remember.
Yes	No.	No.
Yes	Yes; I looked up information on the internet or in a book.	No.
Yes	No.	No.
Yes	No.	No.
Yes	No.	No.
Yes	No.	Yes; I asked a friend or family member for help.
Yes	No.	Yes; I wrote down the problem or something about the problem in my notes., Yes; I tried to figure out what I did wrong without using outside sources.
Yes	Yes; I did something other than the options above.	No.
I don't remember.	I don't remember.	I don't remember.
Yes	Yes; I did something other than the options above.	No.

Yes   Yes; I did something other than the   No.
options above., I worked the
problem

Addendum: Questions from Digital Electronics' Survey 2

Feedback on Edpuzzle

For this survey, I'm curious about feedback you get from watching a video without questions. You recently watched an Edpuzzle on K-mapping that had no formal questions, but did give you chances to pause and try problems. Please answer the following questions with that Edpuzzle in mind. All survey questions are optional.

1. **Do you prefer an Edpuzzle with questions? (In this case, I mean real, graded questions and not just opportunities to pause and try a problem.)**
   Mark only one oval.

   ◯ Yes

   ◯ No

   ◯ No preference.

2. **Why do you have this preference (or lack of preference)?**

   _____

   _____

   _____

   _____

   _____

3. **Do you find that having questions (again, real questions, not just examples to try) within the Edpuzzle helps you better understand the content?**
   Mark only one oval.

   ◯ Yes

   ◯ No

   ◯ Sometimes

4. **Why?**

   _____

   _____

   _____

   _____

   _____

Example 1
Please answer the questions below about example 1 on the Edpuzzle.

Example 1

Example:

After labeling and transferring the truth table data into the K-Map, write the simplified sum-of-products (SOP) logic expression for the logic function F_1.

J	K	F_1
0	0	1
0	1	1
1	0	0
1	1	0

5. Did you pause the video to try this example?
Mark only one oval.

◯ Yes

◯ No

◯ I don't remember.

6. Did you feel like pausing the video and trying this example helped you learn?
Mark only one oval.

◯ Yes; it was very helpful!

◯ Yes; it was somewhat helpful.

◯ No

◯ I didn't pause the video and/or don't remember pausing the video to try a problem.

7. Did you do anything BEFORE tried this example? Select all that apply.
Check all that apply.

☐ Yes; I rewatched a section of the video.

☐ Yes; I looked up information on the internet or in a book.

☐ Yes; I asked for help from a teacher, friend, or family member.

☐ No.

☐ I don't remember.

☐ I didn't pause the video and/or don't remember pausing the video to try a problem.

☐ Other: _____

8. Did you do anything AFTER you found out if you were correct or not? Select all that apply.

Check all that apply.

- ☐ Yes; I wrote down the problem or something about the problem in my notes.
- ☐ Yes; I rewatched a section of the video.
- ☐ Yes; I asked a friend or family member for help.
- ☐ Yes; I emailed my teacher for help.
- ☐ Yes; I plan to ask my teacher for help in class.
- ☐ Yes; I looked up more information in a book or on the internet.
- ☐ Yes; I tried to figure out what I did wrong without using outside sources.
- ☐ No.
- ☐ I don't remember.
- ☐ I didn't pause the video and/or don't remember pausing the video to try a problem.
- ☐ Other: _____

Example 2

Please answer the questions below about example 2 on the Edpuzzle.

Example 2

Three Variable K-Map

	W	X	Y	F_{WXY}
Minterm – 0	0	0	0	1
Minterm – 1	0	0	1	0
Minterm – 2	0	1	0	0
Minterm – 3	0	1	1	0
Minterm – 4	1	0	0	0
Minterm – 5	1	0	1	1
Minterm – 6	1	1	0	1
Minterm – 7	1	1	1	0

9. Did you pause the video to try this example?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ I don't remember.

10. Did you feel like pausing the video and trying this example helped you learn?

Mark only one oval.

- ◯ Yes; it was very helpful!
- ◯ Yes; it was somewhat helpful.
- ◯ No
- ◯ I didn't pause the video and/or don't remember pausing the video to try a problem.

11. Did you do anything BEFORE tried this example? Select all that apply.

Check all that apply.

☐ Yes; I rewatched a section of the video.

☐ Yes; I looked up information on the internet or in a book.

☐ Yes; I asked for help from a teacher, friend, or family member.

☐ No.

☐ I don't remember.

☐ I didn't pause the video and/or don't remember pausing the video to try a problem.

☐ Other: _____

12. Did you do anything AFTER you found out if you were correct or not? Select all that apply.

Check all that apply.

☐ Yes; I wrote down the problem or something about the problem in my notes.

☐ Yes; I rewatched a section of the video.

☐ Yes; I asked a friend or family member for help.

☐ Yes; I emailed my teacher for help.

☐ Yes; I plan to ask my teacher for help in class.

☐ Yes; I looked up more information in a book or on the internet.

☐ Yes; I tried to figure out what I did wrong without using outside sources.

☐ No.

☐ I don't remember.

☐ I didn't pause the video and/or don't remember pausing the video to try a problem.

☐ Other: _____

Example 3
Please answer the questions below about example 3 on the Edpuzzle.

Example 3

Example:

After labeling and transferring the truth table data into the K-Map, write the simplified sum-of-products (SOP) logic expression for the logic function F_2.

E	F	G	F_2
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

13. **Did you pause the video to try this example?**
Mark only one oval.

- ⚪ Yes
- ⚪ No
- ⚪ I don't remember.

14. **Did you feel like pausing the video and trying this example helped you learn?**
Mark only one oval.

- ⚪ Yes; it was very helpful!
- ⚪ Yes; it was somewhat helpful.
- ⚪ No
- ⚪ I didn't pause the video and/or don't remember pausing the video to try a problem.

15. **Did you do anything BEFORE tried this example? Select all that apply.**
Check all that apply.

- ☐ Yes; I rewatched a section of the video.
- ☐ Yes; I looked up information on the internet or in a book.
- ☐ Yes; I asked for help from a teacher, friend, or family member.
- ☐ No.
- ☐ I don't remember.
- ☐ I didn't pause the video and/or don't remember pausing the video to try a problem.
- ☐ Other: _____

16. **Did you do anything AFTER you found out if you were correct or not? Select all that apply.**
Check all that apply.

- ☐ Yes; I wrote down the problem or something about the problem in my notes.
- ☐ Yes; I rewatched a section of the video.
- ☐ Yes; I asked a friend or family member for help.
- ☐ Yes; I emailed my teacher for help.
- ☐ Yes; I plan to ask my teacher for help in class.
- ☐ Yes; I looked up more information in a book or on the internet.
- ☐ Yes; I tried to figure out what I did wrong without using outside sources.
- ☐ No.
- ☐ I don't remember.
- ☐ I didn't pause the video and/or don't remember pausing the video to try a problem.
- ☐ Other: _____

Example 4
Please answer the questions below about example 4 on the Edpuzzle.

Example 4

Four Variable K-Map

	W	X	Y	Z	F$_{wxyz}$
Minterm – 0	0	0	0	0	0
Minterm – 1	0	0	0	1	1
Minterm – 2	0	0	1	0	1
Minterm – 3	0	0	1	1	0
Minterm – 4	0	1	0	0	1
Minterm – 5	0	1	0	1	1
Minterm – 6	0	1	1	0	0
Minterm – 7	0	1	1	1	1
Minterm – 8	1	0	0	0	0
Minterm – 9	1	0	0	1	0
Minterm – 10	1	0	1	0	1
Minterm – 11	1	0	1	1	0
Minterm – 12	1	1	0	0	1
Minterm – 13	1	1	0	1	0
Minterm – 14	1	1	1	0	1
Minterm – 15	1	1	1	1	1
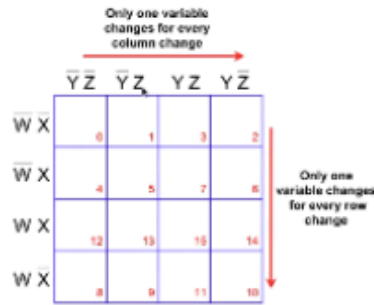
17. **Even though I didn't tell you to, did you pause the video to try this example?**
   Mark only one oval.

   ○ Yes

   ○ No

   ○ I don't remember.

18. **Did you feel like pausing the video and trying this example helped you learn?**
   Mark only one oval.

   ○ Yes; it was very helpful!

   ○ Yes; it was somewhat helpful.

   ○ No

   ○ I didn't pause the video and/or don't remember pausing the video to try a problem.

19. **Did you do anything BEFORE tried this example? Select all that apply.**
   Check all that apply.

   ☐ Yes; I rewatched a section of the video.

   ☐ Yes; I looked up information on the internet or in a book.

   ☐ Yes; I asked for help from a teacher, friend, or family member.

   ☐ No.

   ☐ I don't remember.

   ☐ I didn't pause the video and/or don't remember pausing the video to try a problem.

   ☐ Other: _____

20. Did you do anything AFTER you found out if you were correct or not? Select all that apply.

Check all that apply.

☐ Yes; I wrote down the problem or something about the problem in my notes.

☐ Yes; I rewatched a section of the video.

☐ Yes; I asked a friend or family member for help.

☐ Yes; I emailed my teacher for help.

☐ Yes; I plan to ask my teacher for help in class.

☐ Yes; I looked up more information in a book or on the internet.

☐ Yes; I tried to figure out what I did wrong without using outside sources.

☐ No.

☐ I don't remember.

☐ I didn't pause the video and/or don't remember pausing the video to try a problem.

☐ Other: _____

Example 5
Please answer the questions below about example 5 on the Edpuzzle.

Example 5

Example:

After labeling and transferring the truth table data into the K-Map, write the simplified sum-of-products (SOP) logic expression for the logic function F_4. Be sure to take advantage of the *don't care* conditions.

R	S	T	U	F_4
0	0	0	0	X
0	0	0	1	0
0	0	1	0	1
0	0	1	1	X
0	1	0	0	0
0	1	0	1	X
0	1	1	0	X
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	X
1	1	0	0	X
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

27

21. Did you pause the video to try this example?

Mark only one oval.

◯ Yes

◯ No

◯ I don't remember.

22. **Did you feel like pausing the video and trying this example helped you learn?**
Mark only one oval.

- ( ) Yes; it was very helpful!
- ( ) Yes; it was somewhat helpful.
- ( ) No
- ( ) I didn't pause the video and/or don't remember pausing the video to try a problem.

23. **Did you do anything BEFORE tried this example? Select all that apply.**
Check all that apply.

- [ ] Yes; I rewatched a section of the video.
- [ ] Yes; I looked up information on the internet or in a book.
- [ ] Yes; I asked for help from a teacher, friend, or family member.
- [ ] No.
- [ ] I don't remember.
- [ ] I didn't pause the video and/or don't remember pausing the video to try a problem.
- [ ] Other: _____

24. **Did you do anything AFTER you found out if you were correct or not? Select all that apply.**
Check all that apply.

- [ ] Yes; I wrote down the problem or something about the problem in my notes.
- [ ] Yes; I rewatched a section of the video.
- [ ] Yes; I asked a friend or family member for help.
- [ ] Yes; I emailed my teacher for help.
- [ ] Yes; I plan to ask my teacher for help in class.
- [ ] Yes; I looked up more information in a book or on the internet.
- [ ] Yes; I tried to figure out what I did wrong without using outside sources.
- [ ] No.
- [ ] I don't remember.
- [ ] I didn't pause the video and/or don't remember pausing the video to try a problem.
- [ ] Other: _____

Additional Comments

25. **Please provide any additional comments about this Edpuzzle.**

_____

_____

_____

_____

_____

APPENDIX T

Addendum: Survey 2 Responses from Digital Electronics

Do you prefer an Edpuzzle with questions? (In this case, I mean real, graded questions and not just opportunities to pause and try a problem.)	Why do you have this preference (or lack of preference)?	Do you find that having questions (again, real questions, not just examples to try) within the Edpuzzle helps you better understand the content?	Why?
Yes	It gives a real opportunity to stop and practice whats being explained.	Yes	I honestly learn better from seeing an example and then using it myself.
Yes	Real questions force one to try and figure something out.	Yes	Failure to understand a question initially causes one to rethink and redo a problem
Yes	I feel like if I do not have questions I will tend to lose focus and not learn as well.	Yes	It helps me understand formulas and trying to figure out the variables and solutions because without those questions, I wouldn't be familiar with anything I am tested on.
Yes	Because I like to know what I am doing.	Yes	Cause I like to do questions.
Yes	I just like it better	Yes	No idea
Yes	I like having questions because it helps us practice while its fresh on our minds	Yes	Again its fresh on our minds from you teaching us through the edpuzzle
No preference.	Because I'm fine with whatever is decided.	Yes	Because when I'm able to see that I got it right, it helps me to remember.
No preference.	I still learn the same things either way, and I	Yes	They make it so you have to understand the content

	do the examples in the video so really even if there's no questions I'm still getting practice in.		more to answer the questions.
No	The grade stresses me out and when I get stressed out I can't do my best.	Yes	Because you have to actually do the problem and you can't just skip it.
No preference.	Like I don't mind doing the questions but I don't know if not doing them affects me negatively so I have no preference	Sometimes	The examples help me understand it just as much because either way if I don't understand it I just ask you
No	If i don't understand a topic from the EdPuzzle i don't have the option to ask for help and end up with a bad grade.	Sometimes	It varies depending on the question but for the most part if i get it i get it and if not i will need some extra help.
No	It makes me need to pay attention and it doesn't stop so I can't just look back through a section to find the answer to the questions.	No	Because with questions I have to remember what we were just talking about and it will make me get confused easier if I were not to understand it.

Did you pause the video to try this example?	Did you feel like pausing the video and trying this example helped you learn?	Did you do anything BEFORE tried this example? Select all that apply.	Did you do anything AFTER you found out if you were correct or not? Select all that apply.
Problem 1			
No Answer	No Answer	No Answer	No Answer
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.
No	I didn't pause the video and/or don't remember	I didn't pause the video and/or don't	I didn't pause the video and/or don't remember

	pausing the video to try a problem.	remember pausing the video to try a problem.	pausing the video to try a problem.
Yes	Yes; it was very helpful!	Yes; I asked for help from a teacher, friend, or family member.	Yes; I asked a friend or family member for help.
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.
I don't remember.	Yes; it was somewhat helpful.	I don't remember.	No.
Yes	Yes; it was very helpful!	No.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	Yes; it was very helpful!	No.	No.
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	No.	Yes; I tried to figure out what I did wrong without using outside sources.
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	Yes; I rewatched a section of the video.	
Yes	Yes; it was somewhat helpful.	No.	No.
Yes	Yes; it was somewhat helpful.	No.	No.

Problem 2

No Answer	No Answer	No Answer	No Answer
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the	I didn't pause the video and/or don't remember pausing the video to try a problem.

		video to try a problem.	
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.
No	Yes; it was somewhat helpful.	I don't remember.	Yes; I rewatched a section of the video.
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.
I don't remember.	Yes; it was somewhat helpful.	No.	No.
Yes	Yes; it was very helpful!	No.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	Yes; it was very helpful!	No.	No.
Yes	Yes; it was very helpful!	No.	No.
Yes	Yes; it was very helpful!	No.	I did the part on the homework that was like that
Yes	Yes; it was somewhat helpful.	No.	No.
Yes	Yes; it was very helpful!	No.	No.

Problem 3

No Answer	No Answer	No Answer	No Answer
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.
No	I didn't pause the video and/or don't remember	I didn't pause the video	I didn't pause the video and/or don't remember

	pausing the video to try a problem.	and/or don't remember pausing the video to try a problem.	pausing the video to try a problem.
I don't remember.	Yes; it was very helpful!	I don't remember.	Yes; I looked up more information in a book or on the internet.
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.
I don't remember.	Yes; it was somewhat helpful.	No.	No.
Yes	Yes; it was very helpful!	No.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	Yes; it was very helpful!	No.	No.
Yes	Yes; it was very helpful!	Yes; I rewatched a section of the video.	Yes; I tried to figure out what I did wrong without using outside sources.
Yes	Yes; it was somewhat helpful.	No.	I did the part on the homework that was like this
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	No.	No.

Problem 4

No Answer	No Answer	No Answer	No Answer

No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.
I don't remember.	I didn't pause the video and/or don't remember pausing the video to try a problem.	Yes; I rewatched a section of the video.	Yes; I asked a friend or family member for help.
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	No.	No.
Yes	Yes; it was very helpful!	No.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	Yes; it was very helpful!	No.	No.
Yes	Yes; it was very helpful!	Yes; I rewatched a section of the video.	I don't remember.
Yes	Yes; it was very helpful!	No.	hw
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the	I didn't pause the video and/or don't remember pausing the video to try a problem.

		video to try a problem.	
Yes	Yes; it was somewhat helpful.	No.	Yes; I rewatched a section of the video.

Problem 5

No Answer	No Answer	No Answer	No Answer
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	No.	Yes; I tried to figure out what I did wrong without using outside sources.
No	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.	I didn't pause the video and/or don't remember pausing the video to try a problem.
I don't remember.	Yes; it was somewhat helpful.	No.	No.
Yes	Yes; it was very helpful!	No.	Yes; I wrote down the problem or something about the problem in my notes.
Yes	Yes; it was very helpful!	No.	No.
Yes	Yes; it was very helpful!	No.	Yes; I tried to figure out what I did wrong without using outside sources.
No	No	No.	No.

| No | I didn't pause the video and/or don't remember pausing the video to try a problem. | I didn't pause the video and/or don't remember pausing the video to try a problem. | I didn't pause the video and/or don't remember pausing the video to try a problem. |
| No | No | No. | No. |

Please provide any additional comments about this Edpuzzle.

No Answer

I didn't pause the video in order to work on another assignment.

No Answer

No Answer

I feel that a question popping up and giving me a chance to get a grade makes it more likely to do the problem and better understand the content.

No Answer

Nothing else to say.

No Answer

No Answer

thanks

No Answer

No Answer

Addendum: Questions from Digital Electronics' Survey 3

Feedback on Edpuzzle

For this survey, I'm curious about feedback you get from watching a video without questions. You recently watched an Edpuzzle on NAND & NOR logic that had no formal questions and did not ask you to pause and try problems. Please answer the following questions with that Edpuzzle in mind. All survey questions are optional.

Preference on questions in Edpuzzles.
Please indicate if you agree or disagree with the following statements.

1. **I prefer an Edpuzzle with embedded questions that I have to answer before I can move on.**
   Mark only one oval.

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

2. **I prefer an Edpuzzle with prompts to pause and try a problem.**
   Mark only one oval.

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

3. **I prefer an Edpuzzle that simply explains the process and shows me how to do problems.**
   Mark only one oval.

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

4. **Please tell me more about your preference.**

   _____

   _____

   _____

   _____

   _____

5. During the Edpuzzle, did you ever pause and try a problem even though you weren't prompted to?

Mark only one oval.

◯ Yes

◯ No

◯ I do not remember.

Learning from questions in Edpuzzles.

Please indicate if you agree or disagree with the following statements.

6. Having questions I must answer before I move on in the Edpuzzles helps me learn.

Mark only one oval.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

7. Opportunities to pause and try problems in an Edpuzzle help me learn.

Mark only one oval.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

8. Edpuzzles with no questions nor prompts to pause and try a problem help me learn.

Mark only one oval.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

9. Please tell me more about what helps you learn on an Edpuzzle.

_____

_____

_____

_____

_____

APPENDIX V

Addendum: Survey 3 Responses from Digital Electronics

I prefer an Edpuzzle with embedded questions that I have to answer before I can move on.	I prefer an Edpuzzle with prompts to pause and try a problem.	I prefer an Edpuzzle that simply explains the process and shows me how to do problems.	Please tell me more about your preference.	During the Edpuzzle, did you ever pause and try a problem even though you weren't prompted to?
Neutral	Neutral	Neutral	I'm fine with whatever is decided.	Yes
Neutral	Agree	Agree	I like when there's pauses to try a problem after an example just like it was given to make sure I understand what to do.	Yes
Disagree	Agree	Agree	it gives me anxiety when there are questions i have to do and it stresses me out pls	I do not remember.
Disagree	Agree	Agree	I like the ones that just give you a question to try on you own rather than putting one on the ed puzzle before moving on, because most of the time I don't necessarily know what I'm doing at that moment, but once I see more I can fully understand what is going on.	Yes
Strongly Agree	Strongly Disagree	Agree	I prefer the embedded questions and the simply explained method most because they both help me remember what I just learned, but the one with the embedded questions does it better.	No

Agree	Agree	Disagree	It really depends. Like on this one I would've liked questions because I'm confused but on the last one I didn't need them because it was easy. So, I feel like if it's adding onto a new topic like the last one, I don't need them, but this is a new topic kind of so I need them.	No
Strongly Agree	Agree	Disagree		No
Strongly Agree	Strongly Agree	Neutral	Ed puzzle with actual work	No
Neutral	Neutral	Strongly Agree		No
Agree	Neutral	Disagree	I like to do the problem and know whether or not I got it right so that I can fix it as soon as possible.	No
Agree	Agree	Neutral	I didn't mind having questions in the edpuzzle.	Yes
Having questions I must answer before I move on in the Edpuzzles helps me learn.	Opportunities to pause and try problems in an Edpuzzle help me learn.	Edpuzzles with no questions nor prompts to pause and try a problem help me learn.	Please tell me more about what helps you learn on an Edpuzzle.	
Agree	Agree	Agree	When I actually get to work something out.	
Agree	Agree	Disagree	Having explanations of how to do the problems before I attempt one just like it helps me learn more.	
Disagree	Agree	Strongly Disagree		

Neutral	Agree	Neutral	I like the questions that I can take and work them myself rather than the ones make me answer them before I can move on. The questions that are given before I can move on really just make me second guess myself to make sure I don't get them wrong so I just forget about learning in that moment. But, getting questions to work on my own time makes me feel that I have more control so I can really take my time on making sure I did everything correctly and that I'm confident
Strongly Agree	Disagree	Agree	Really just the embedded questions and the no questions nor prompts help me learn.
Agree	Agree	Disagree	loads of examples and then a few questions. Doing a lot of questions with little to no examples doesn't help because I don't know how to do it.
Strongly Agree	Neutral	Strongly Disagree	
Agree	Strongly Agree	Neutral	Ed puzzle with questions.
Strongly Agree	Agree	Neutral	
Strongly Agree	Disagree	Strongly Disagree	I will not do a problem unless I have to, so only making me do a problem will help me learn.
Neutral	Neutral	Neutral	

VITA

Work Experience

2013-Present   Northwest Rankin High School, Flowood, Mississippi

- *Teach Principles of Engineering, Digital Electronics, and AP Calculus*
- *Sponsor the NWRHS Robotics Team*
- *Co-chair of the Mathematics Department*
- *Director of the Engineering Academy*
- *February 2016 Teacher of the Month*
- *STAR Teacher 2017, 2018 & 2019*
- *2016-2017 Greater Jackson Area Teacher of the Year*

2012-2013   North Pike High School, Summit, Mississippi

- *Taught Algebra 1 and Transition to Algebra*
- *Served on the TST committee*

2009-2012   McComb High School, McComb, Mississippi

- *Taught Algebra 1 and Honors Geometry*
- *Travelled to Denman Junior High to teach Honors Algebra 1*

2008-2009   Northwest Rankin High School, Flowood, Mississippi

- *Taught Trigonometry and Precalculus*
- *Sponsored Academic Team*

2006-2008   Jackson Preparatory School, Jackson, Mississippi

- *Taught Geometry, Trigonometry, Advanced Algebra and Calculus*
- *Sponsored Mu Alpha Theta*

Education

2003-2006   University of North Carolina, Chapel Hill, North Carolina

- *M.S. in Mathematics, May 2006*
- *Master's Project published October 2007*

1999-2003   Mississippi State University, Starkville, Mississippi

- *B.A. in Mathematics, May 2003*
- *GPA of 4.0 on 4.0 scale*

Skills

- **Software**: Microsoft Office, Google Documents, TI Navigator, Autodesk Inventor, RobotC, and Multisim
- **Hardware**: Texas Instruments calculators, interactive whiteboards, VEX robotics, circuit prototyping
- **Leadership**: Team-teaching, academy director, department co-chair, professional development presenter
- **Teaching**: Project-based learning, dialogic instruction, flipped classroom, incorporating mathematical practices