4-7-2016

Using Just-in-Time Teaching in a Flipped Undergraduate Biological Systems Engineering Course

Jeyamkondan Subbiah
University of Nebraska - Lincoln, jeyam.subbiah@unl.edu

Abstract for DBER Group Discussion on 2016-04-07

Authors and Affiliations:
Jeyamkondan Subbiah
Associate Professor
Biological Systems Engineering and Food Science & Technology
University of Nebraska-Lincoln

Title
Using Just-in-Time Teaching in a Flipped Undergraduate Biological Systems Engineering Course

Abstract
This study analyzed the role of the evidence-based instructional practice of Just-in-time (JIT) teaching integrated with the flipped classroom in an undergraduate biological systems engineering course. In the present paper we provide a detailed overview of the course design, development, and implementation of JIT in a flipped approach to instruction by communicating the technologies used, pedagogy employed to integrate online and in-class activities, and the collaboration between the instructional design support and instructor. Based on the results, we provide recommendations for engineering faculty that want to explore the flipped approach to teaching, examples for online learning activities and how to integrate them with clicker in-class active learning activities to increase student engagement and success rates.

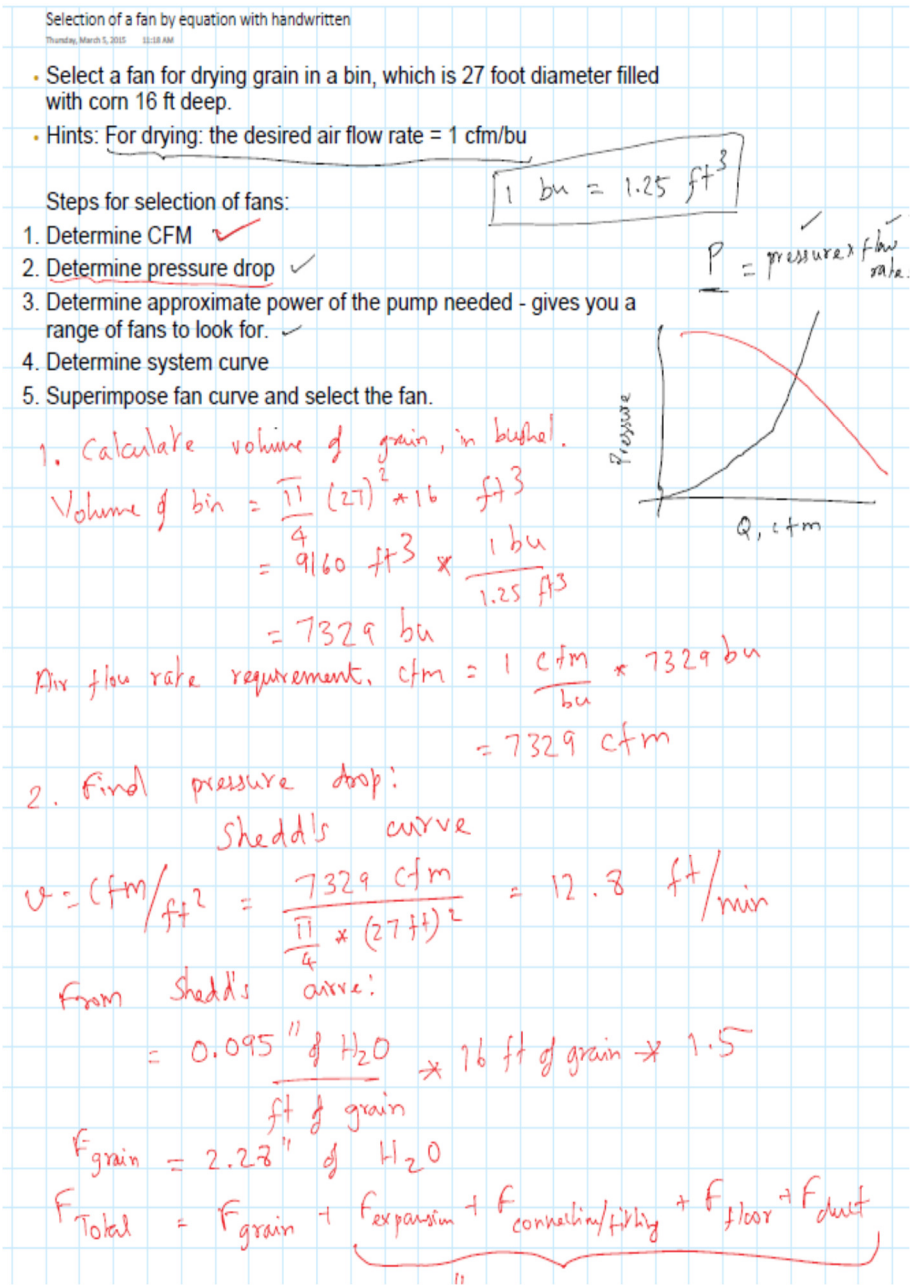
The flipped classroom is a form of blended learning where the lecture is moved outside the classroom with the help of technology and learning activities occur inside the classroom. Thus, in-class time can be devoted to active learning through exercises, projects, and discussions that engage students in higher-order cognitive skills. The flipped classroom has been successfully incorporated into various STEM classrooms (Gannod et al. 2008; Moravec et al. 2010; Talbert 2012). In fact, recently, engineers with an educational research interest have taken notice of the recently popularized, theoretically grounded, concept of flipping the classroom and have been successfully implementing it in their courses (Bishop and Verleger 2013; Bland 2006; Nelson 2015; Toto 2009). However, as the research on flipped instruction in engineering gains momentum, it is essential to understand how specific instructional strategies effect students' learning and perceptions. In this study, we took a close look at the JIT strategy using iClickers to better understand its use and effects on students' learning and perceptions of the course.

The instructional challenges that we sought out to address were a.) the diverse group of students (Agricultural Engineering and Biological Systems Engineering Biological Systems Engineering) needed different paces of learning, b) both groups of students had different interests in course modules of the course, c.) to increase student engagement, students were typically reluctant to speak in the classroom, and d.) class time was short did not allow for high levels of student engagement.

In terms of the flipped element, students began each week watching online annotated video lectures created by the instructor on a surface pro computer and hosted on the university's learning management system Blackboard followed by an online quiz. Then, the instructor would review students' performance and begin each class with the questions that students struggled with the most using iClickers. In terms of the JIT element, the instructor would then adapt his instruction to include a brief summary, overview, or peer-to- peer instruction to enhance students' understanding of the concepts presented in the online lectures.

The results of this study demonstrated the success in combining JIT and the Flipped approach. More specifically, this approach allowed for more classroom time to solve real-world problems through active student engagement in discussions. Just-in-time teaching allowed the instructor to spend dedicated time on unclear and important concept where students needed help the most. Finally, Peer-instruction enhanced student engagement in the class. A t-test analysis comparing students' performance on the online quizzes and the in-class iClicker questions demonstrated students' increased performance post peer discussions and instructor dedicated time on topics.

Figure 1. Still shot from the videos used in the online lectures. With the instructor's stylus-written solutions.



Just-in-Time Teaching in a Flipped Undergraduate Biological Systems Engineering Course

Tareq Daher, Jiajia Chen, David Jones, Jeyam Subbiah
University of Nebraska - Lincoln

Why a flipped design?

Out-of-Class Components that are typically delivered in-class are delivered out-of-class in an LMS	In-Class Time used in-class is used for higher-order thinking and increased student engagement.
Video lectures	Clarify unclear concepts (just-in-time teaching)
Short Quizzes	Problem solving and Discussion
Feedback for Just-in-Time Teaching	Peer instruction (iClickers)

What is JITT

“teaching and learning strategy based on the interaction between web-based study assignments and an active learner classroom. Students respond electronically to carefully constructed web-based assignments which are due shortly before class, and the instructor reads the student submissions "just-in-time" to adjust the classroom lesson to suit the students' needs.”

http://jittdl.physics.iupui.edu/jitt/what.html

Introduction

Using Just-in-time instructional strategies in a flipped classroom to address Instructional Challenges:

AGEN/BSEN 303: Principles of Process Engineering

Course instructor: Dr. Jeyam Subbiah

Teaching Assistant: Jiajia Chen

Instructor Design Support: Dr. Tareq Daher

How often it is taught: Every Spring- Tuesday-Thursdays (3 credits)

Course topic: Selection of fans and pumps

Number of students: 53

Instructional Challenges

1. Diverse group of students need different pace of learning:

- Two diverse group of students – Agricultural Engineering and Biological Systems Engineering
- Biological Systems Engineering likes the selection of pumps for non-Newtonian Fluids
- Agricultural Engineering likes the selection of fan for drying grains in grain bin

2. Difficult to engage students, because they were

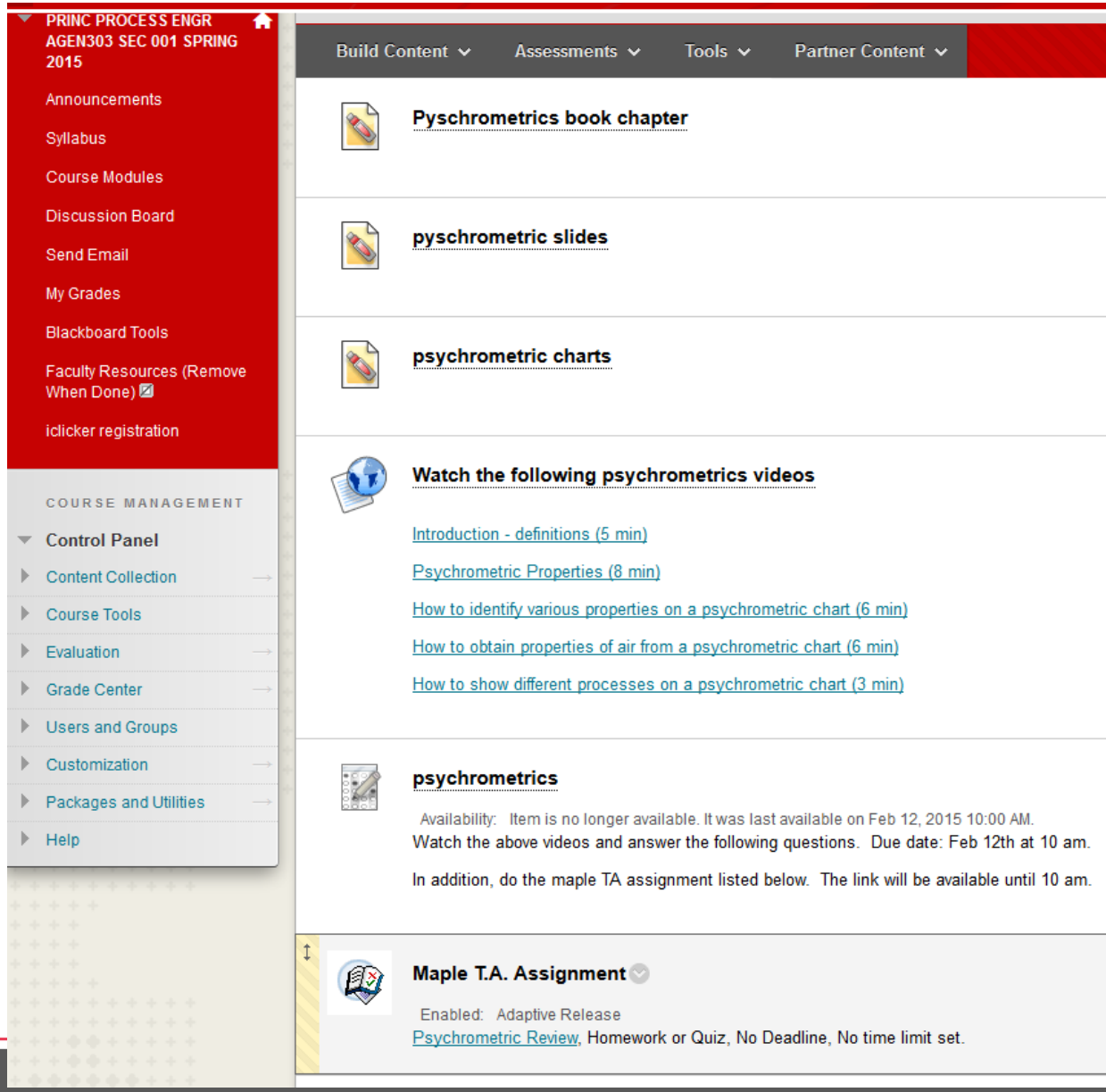
- Reluctant to speak
- Did not have the knowledge to create an informed opinion
- Class time was short did not allow for high levels of student engagement

Addressing the challenges (AGEN/BSEN 303)

Challenges	Course Changes
Diverse group of students	Video lectures allowed them to learn at different paces
Students not reading the text	Pre-quizzes (self-assessment) after the video lectures ensured watching and understanding lectures carefully.
Students not in a knowledge level to engage in discussions	Students engaged in online learning activities that prepared them for in-class discussion and activities.
Students not interested in discussions	Peer-instruction using student response system and problem solving improved engagement
Less time spent on solving real-world problems and discussion	90% of class time used for application and active learning
No feedback from students	Just-in-time teaching and student response system provided feedback to the instructor

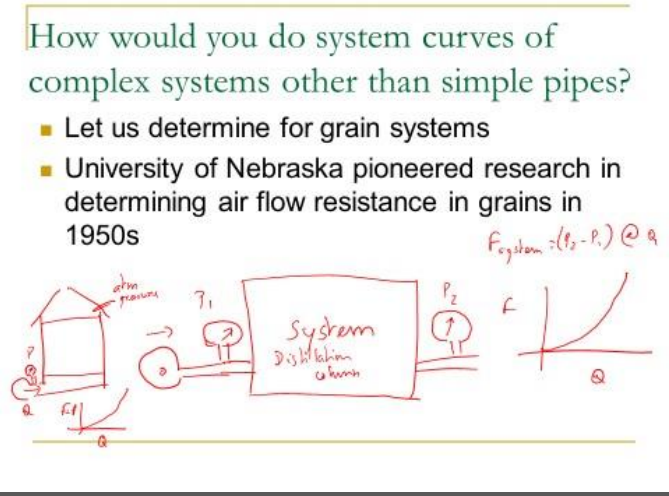
Technology Tools

- View of one lecture folder
- Book chapter
- Slides
- Videos
- Pre-quiz and assignments



Video Recording

- Used a “Surface” Tablet to write on slides
- Used a USB noise-cancelling microphone to record audio
- Used Camtesia Studio to record the video
- Uploaded in YouTube – provided versatility to watch video in computers, tablets, and smart phones



Pore-class Quizes

- After watching the videos, the students have to do quizzes (about 10 multiple choice questions).
- Can have two attempts.
- Question order was changed at each attempt and for each student
- Short question for feedback on content and video quality

Just in Time Teaching

- The class starts with clarification of unclear points
- Students use clickers (student response system) to do few quiz question (in which error was greater than 10%)
- One-two new questions are presented during the class
- Peer-instruction is also used.

Problem Solving in-class

- Used One-Note to solve the problem in Surface Tablet
- Used Adobe-Connect to project on the screen
- Made a pdf file of the solved problem and posted in blackboard.

Selection of a fan by equation with handwritten

Thursday, March 5, 2015 11:18 AM

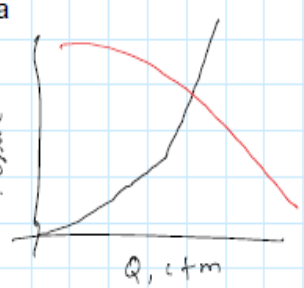
- Select a fan for drying grain in a bin, which is 27 foot diameter filled with corn 16 ft deep.
- Hints: For drying: the desired air flow rate = 1 cfm/bu

1 bu = 1.25 ft³

Steps for selection of fans:

1. Determine CFM ✓
2. Determine pressure drop ✓
3. Determine approximate power of the pump needed - gives you a range of fans to look for. ✓
4. Determine system curve
5. Superimpose fan curve and select the fan.

P = pressure × flow rate



1. Calculate volume of grain, in bushel.

Volume of bin = $\frac{\pi}{4}(27)^2 * 16$ ft³

$= 9160$ ft³ $\times \frac{1 \text{ bu}}{1.25 \text{ ft}^3}$

$= 7329$ bu

Air flow rate requirement, cfm $= 1 \frac{\text{cfm}}{\text{bu}} * 7329$ bu

$= 7329$ cfm

2. Find pressure drop:

Shedd's curve

$v = \text{cfm}/\text{ft}^2 = \frac{7329 \text{ cfm}}{\frac{\pi}{4} * (27 \text{ ft})^2} = 12.8$ ft/min

from Shedd's curve:

$= 0.095 \frac{\text{" of } H_2O}{\text{ft of grain}} * 16$ ft of grain $* 1.5$

$F_{grain} = 2.28$" of H_2O

$F_{Total} = F_{grain} + F_{expansion} + F_{connecting/fitting} + F_{floor} + F_{duct}$

Instructor Perspectives - Videos

- Videos allowed the students to pause or speed-up and replay depending upon the needs of the student.
- This system provided all necessary resources for a student, who is sincere, but need those resources to catch up.

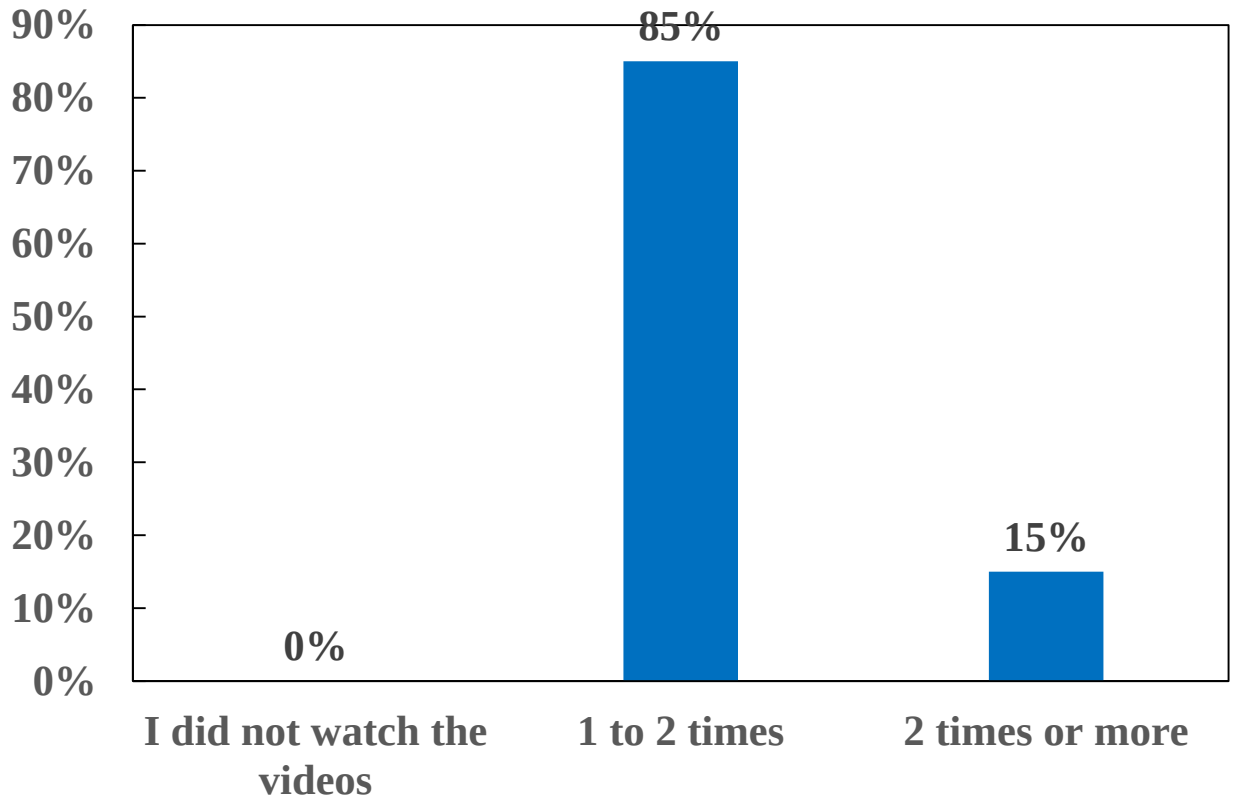
Instructor Perspectives – Pre-class quizzes

- Sometimes, students struggle to answer the quizzes just from watching video. They give excellent feedback telling which concepts they could not understand.
- When the instructor explains those unclear concepts in the class, they pay lot more attention and understand and remember the material longer.
- Without that pre-class quiz experience, the students may not pay attention to those key concepts.
- Pre-class quizzes ensured students to be well-prepared for the class – at least spend 30-45 minutes thinking about the material before coming to the class.

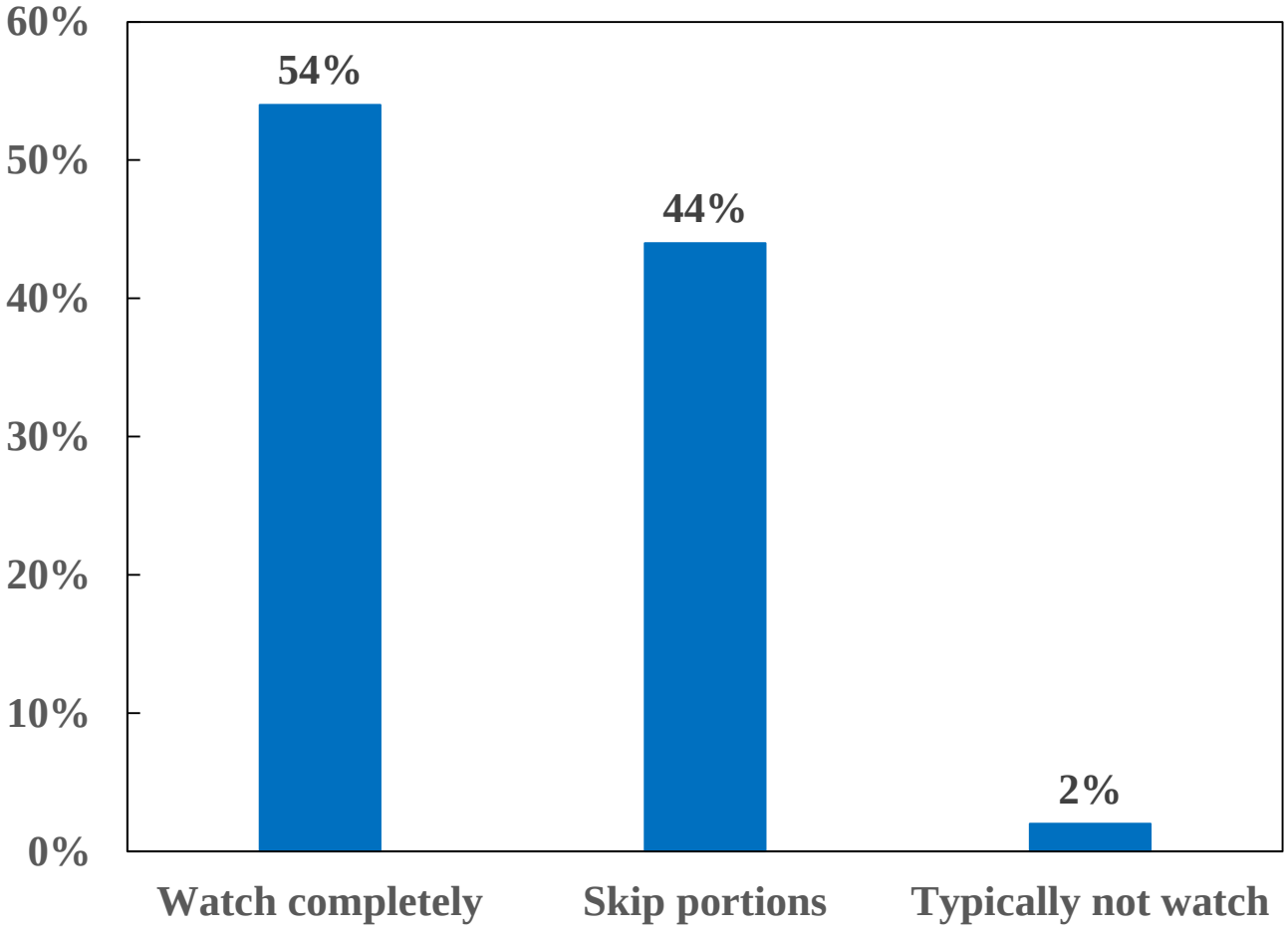
Instructor Perspectives – Peer Instruction

- Instructor used the quizzes (where errors > 10%) as a clicker question in class.
- If errors persist, students discuss in groups and re-answer the same quiz.
- Peer instruction benefits several students
- Similar questions were asked in the exams – which emphasized the students to pay attention

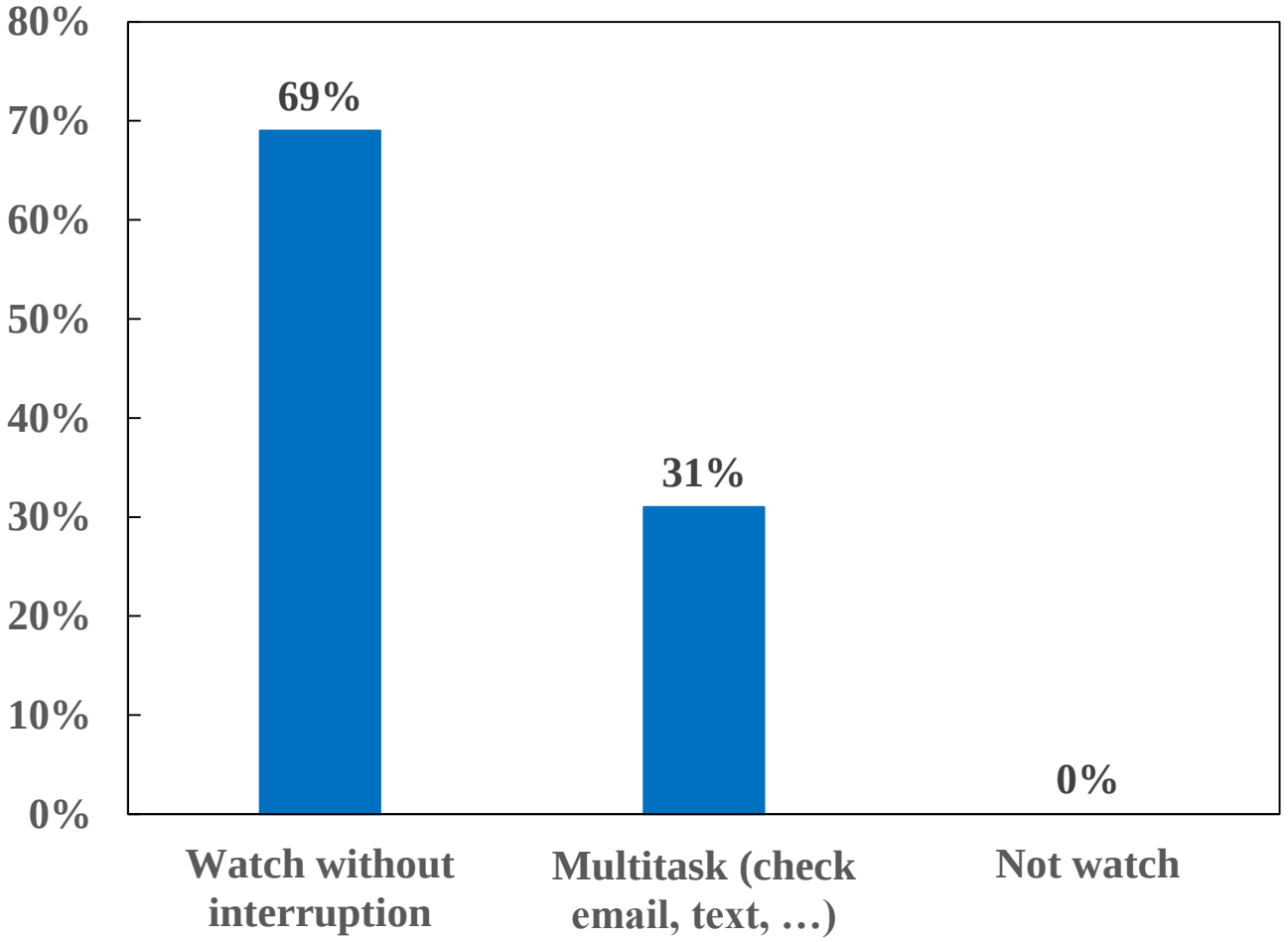
On average, how many times did you watch the videos in order to successfully answer the questions that follow the videos?



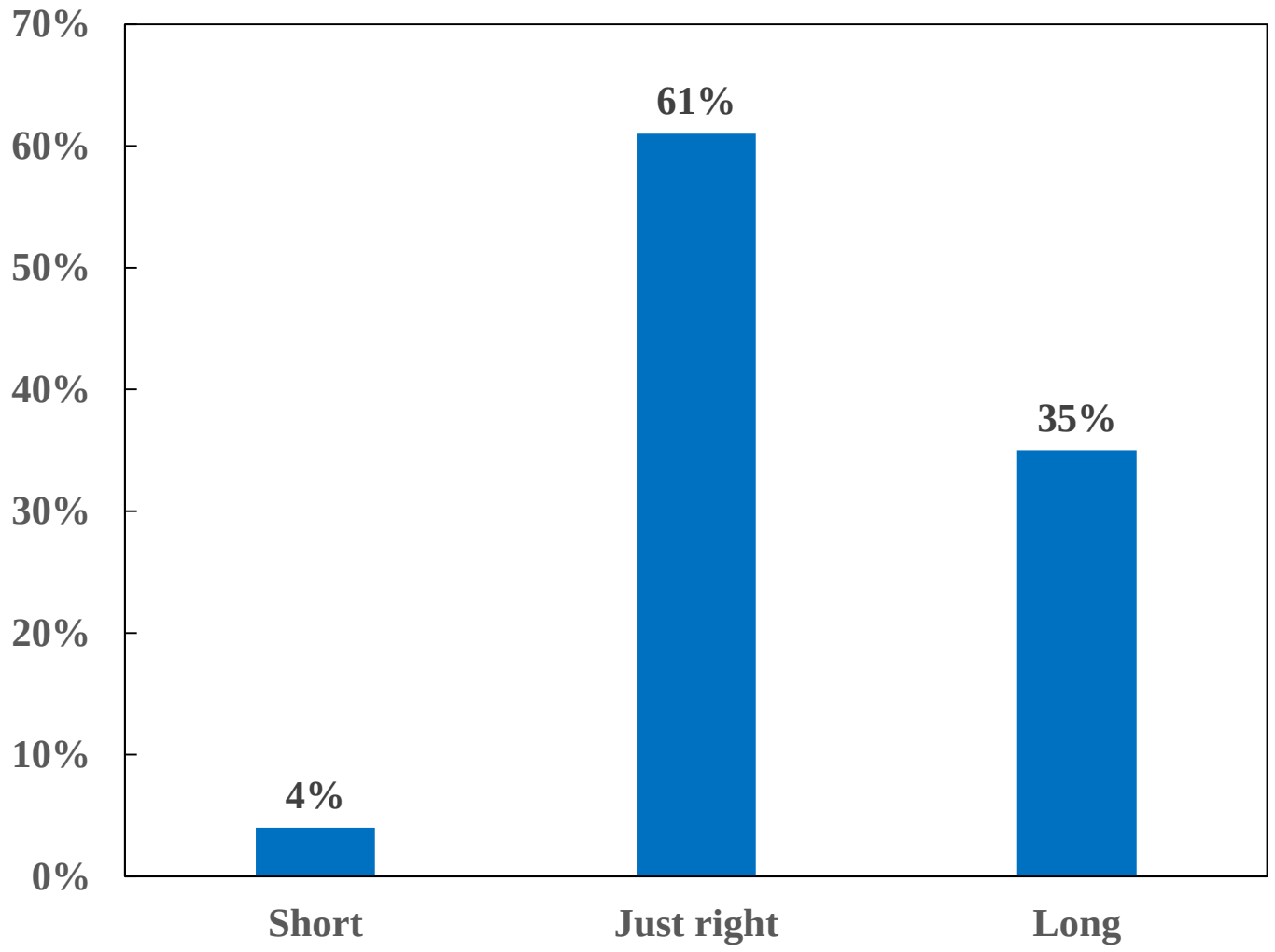
Skipping videos



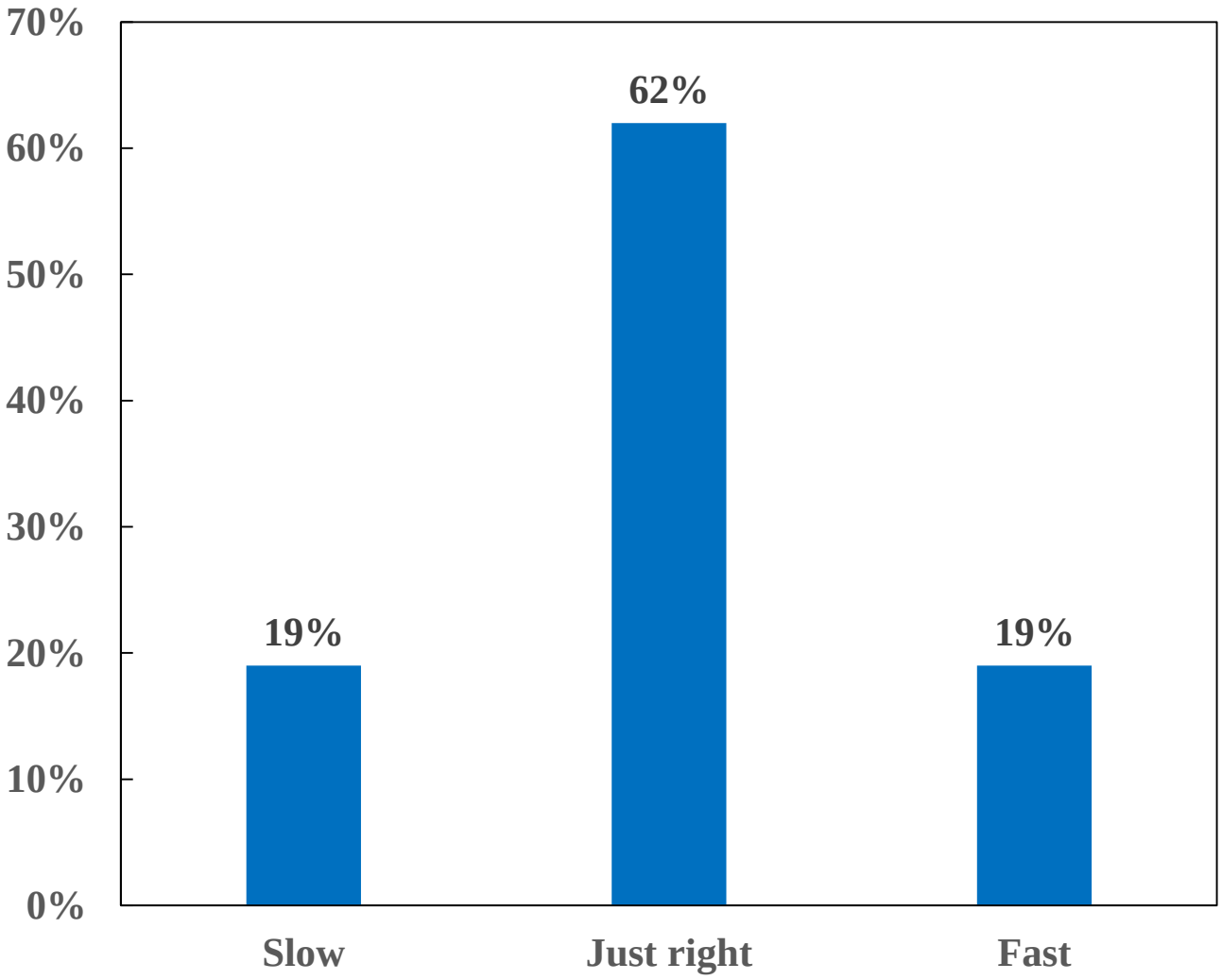
Multi-tasking/Interruptions



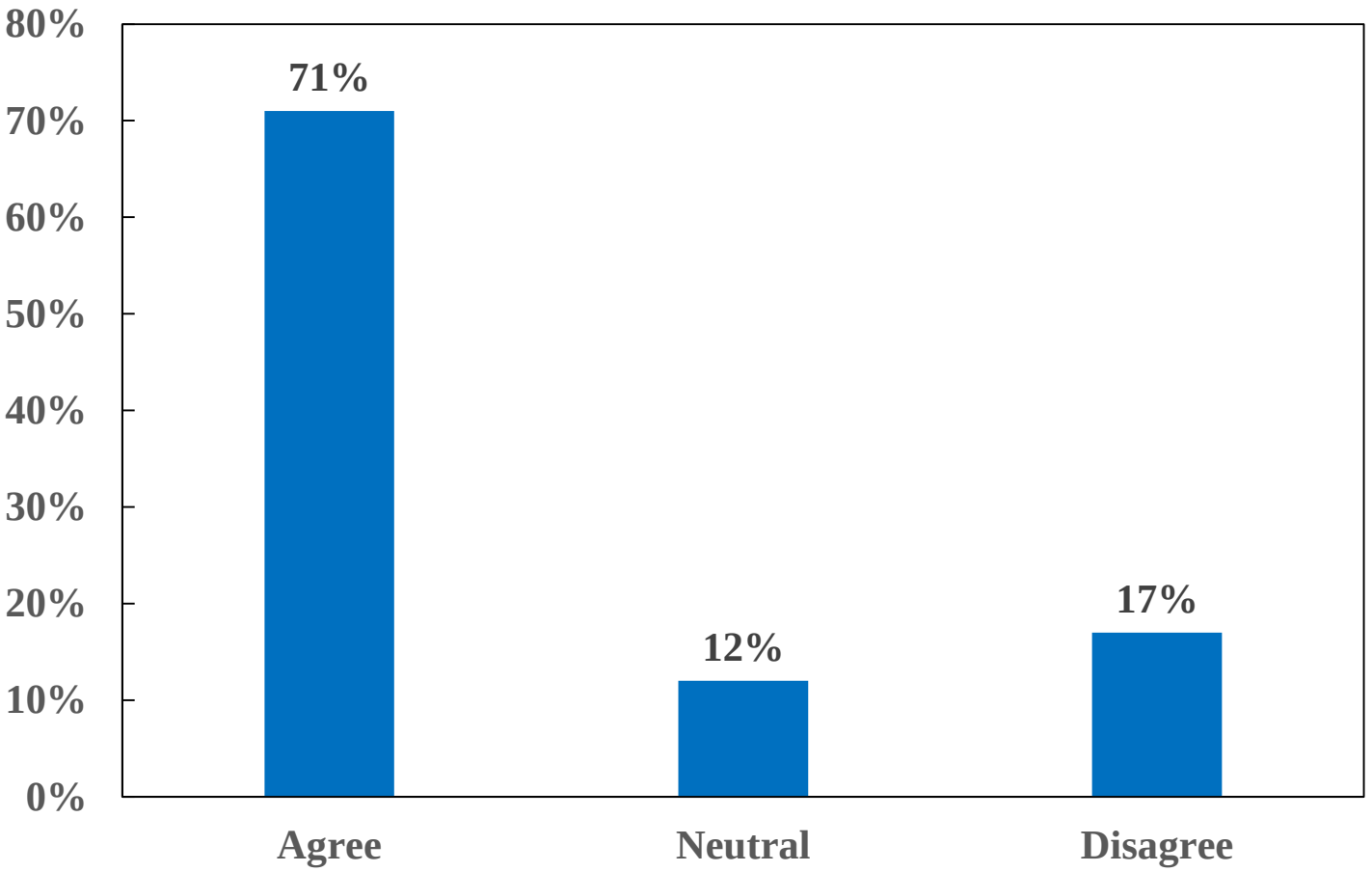
Is the length of the videos



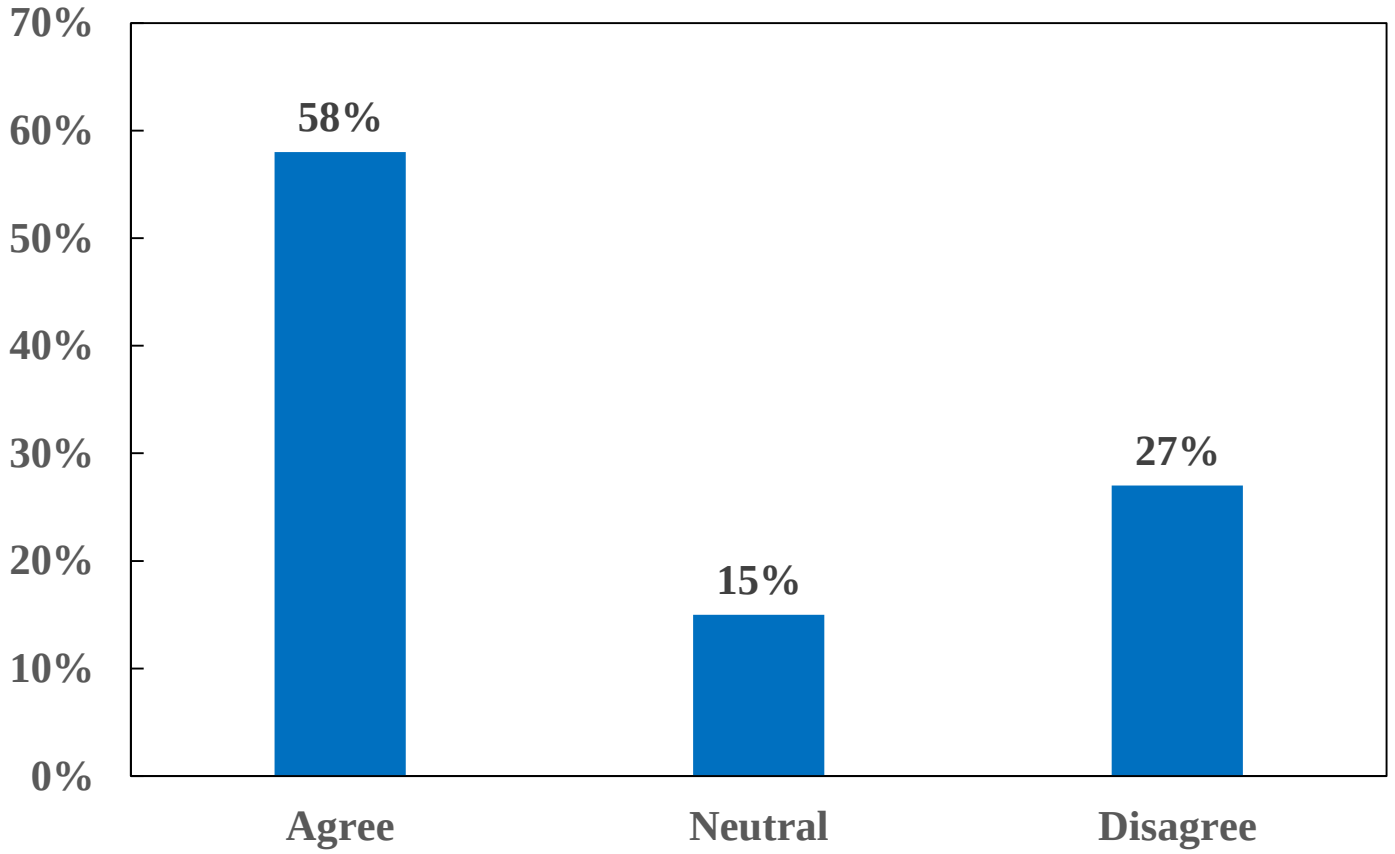
Is the pace of the videos



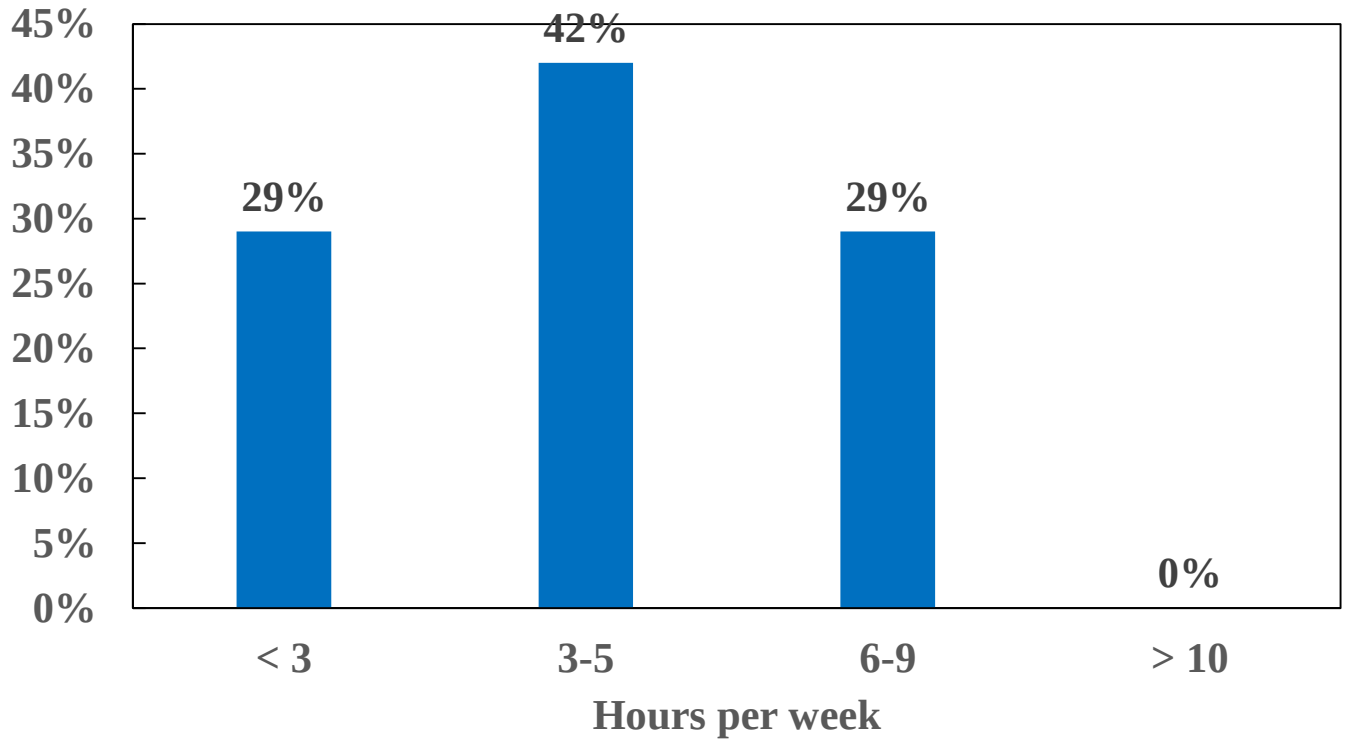
I believe that post-video questions are pertinent and worth completing



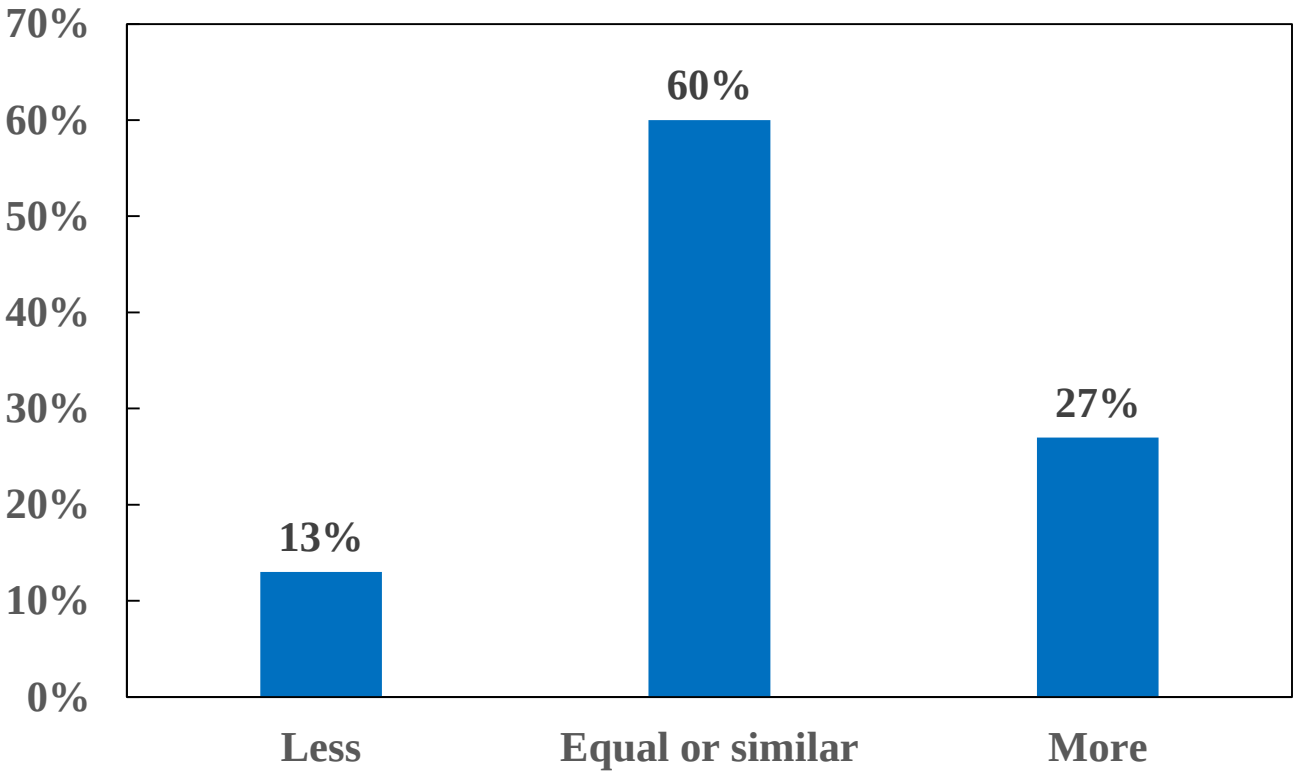
I believe that the post-video questions evaluated my understanding of video content



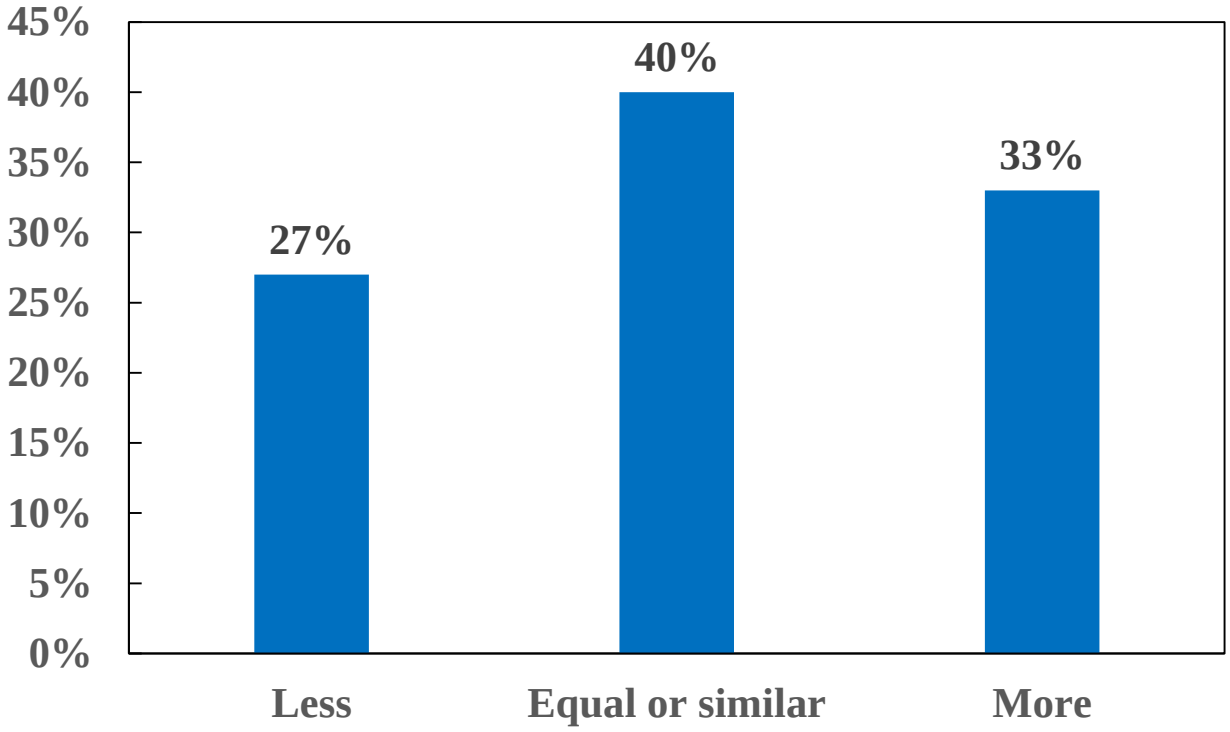
How much time are you spending outside of class per week on this class? (Readings, videos, post-video questions, and others)



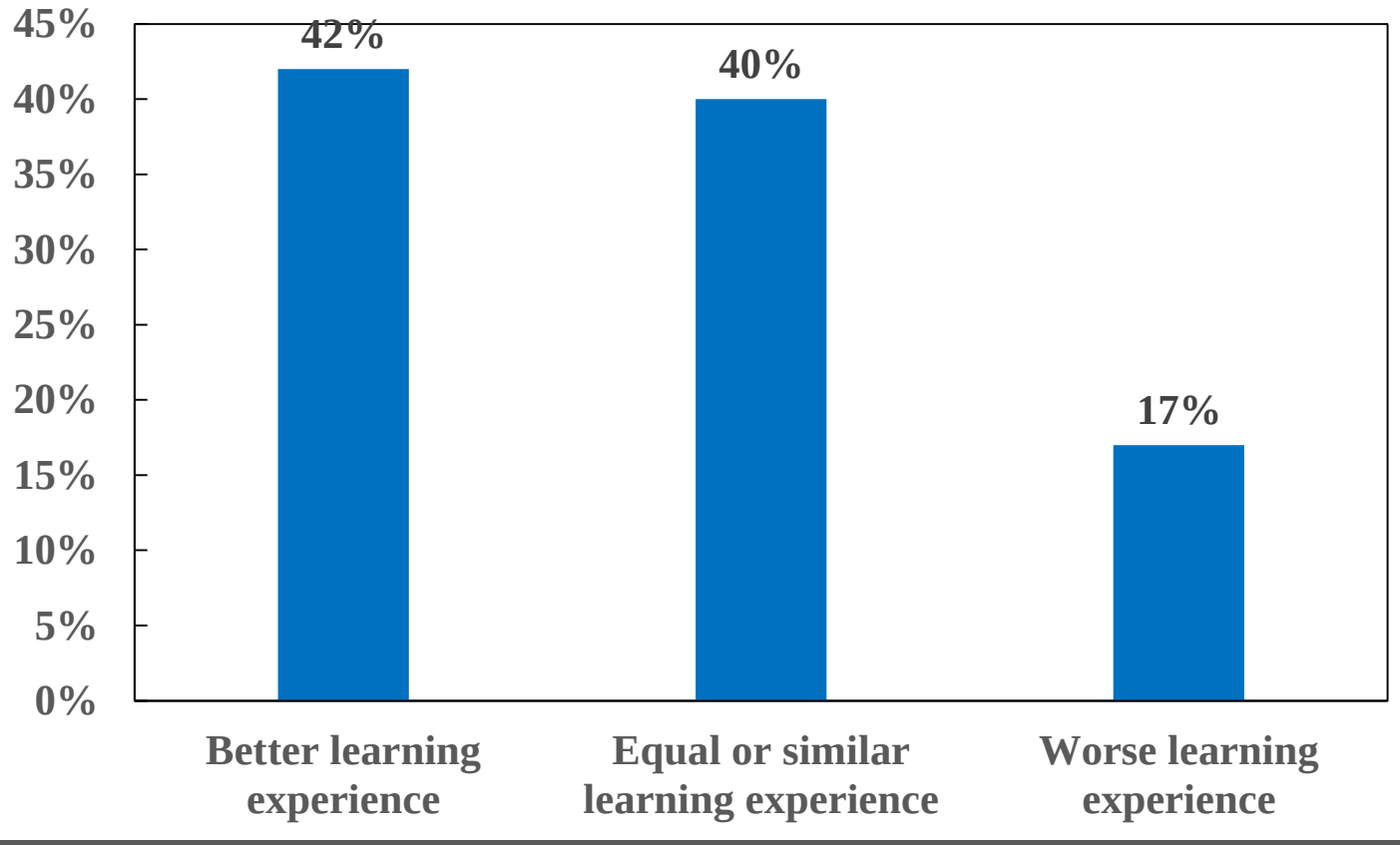
In comparison to traditional lecture courses of the same level in your degree program, the total workload for this flipped class is



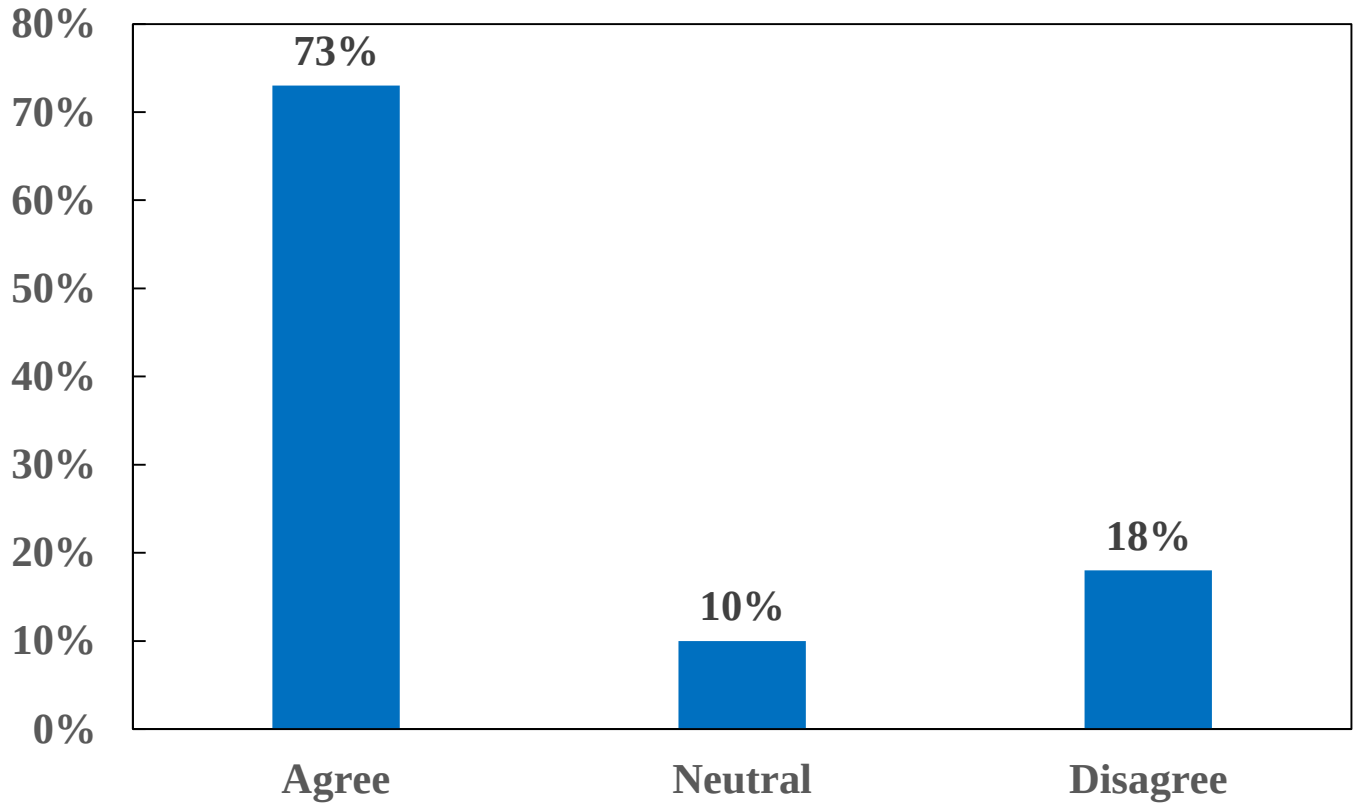
In comparison to traditional lecture courses of the same level in your degree program, how enjoyable was the flipped class experience



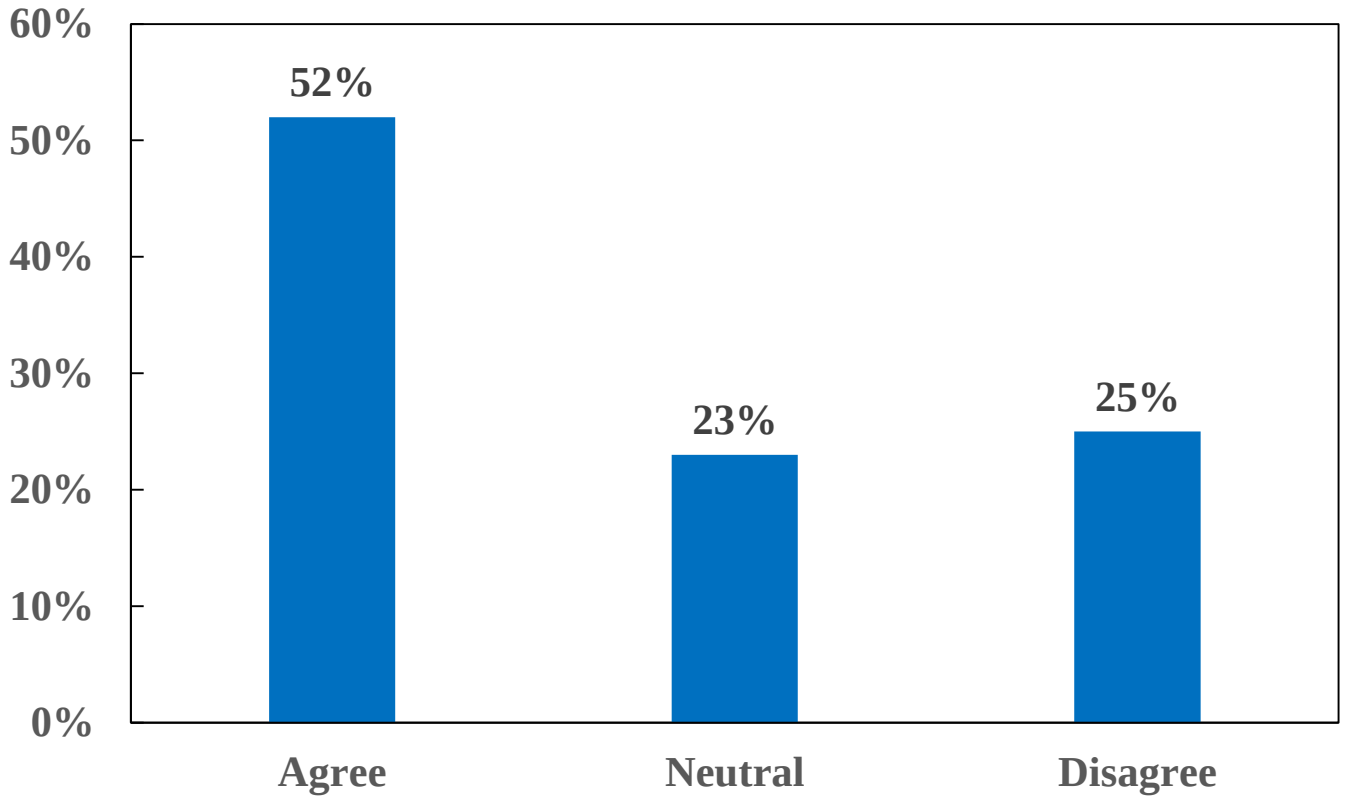
In comparison to traditional lecture courses of the same level in your degree program, this flipped class provided me with a



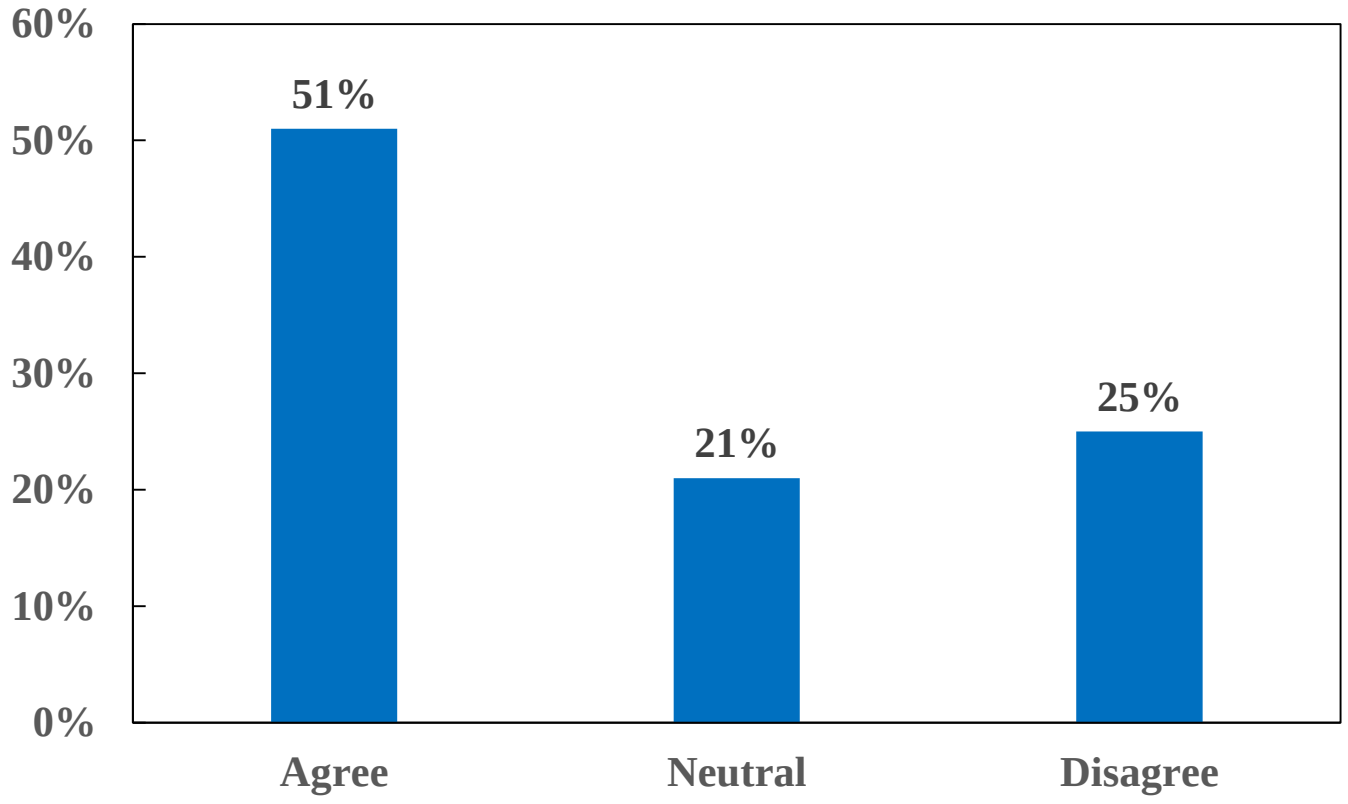
I believe solving problems in class enhanced my understanding of concepts when compared to solving problems out of class time



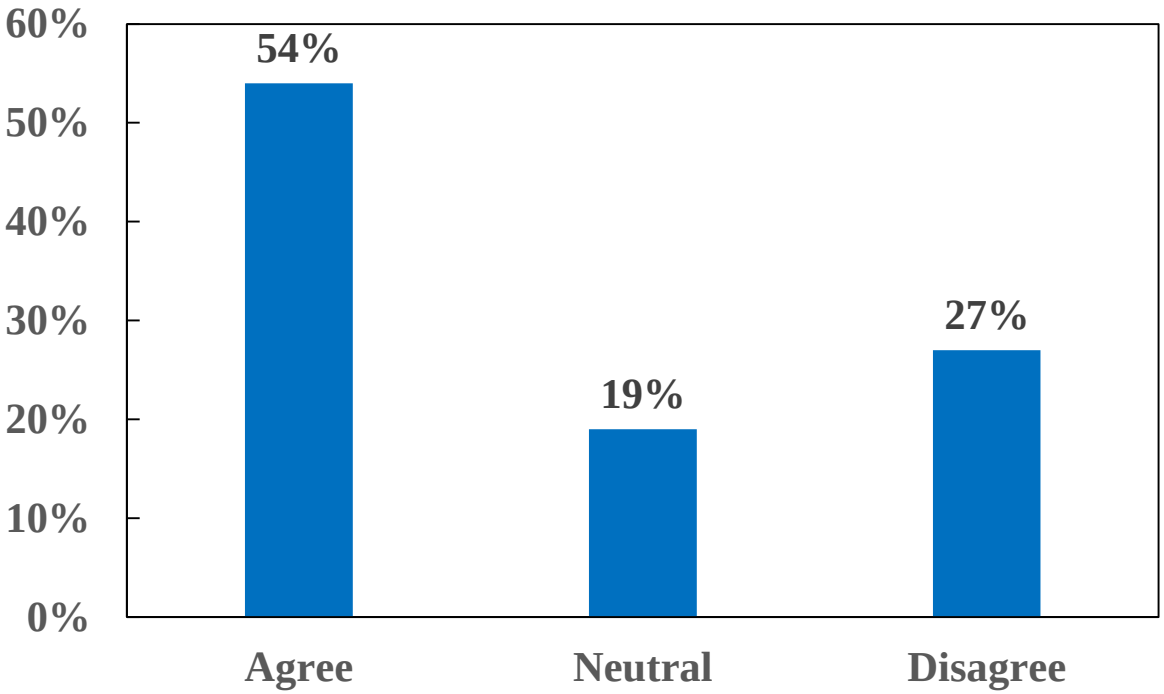
I believe I am better engaged in class activities in flipped design in comparison to a traditional lecture classroom



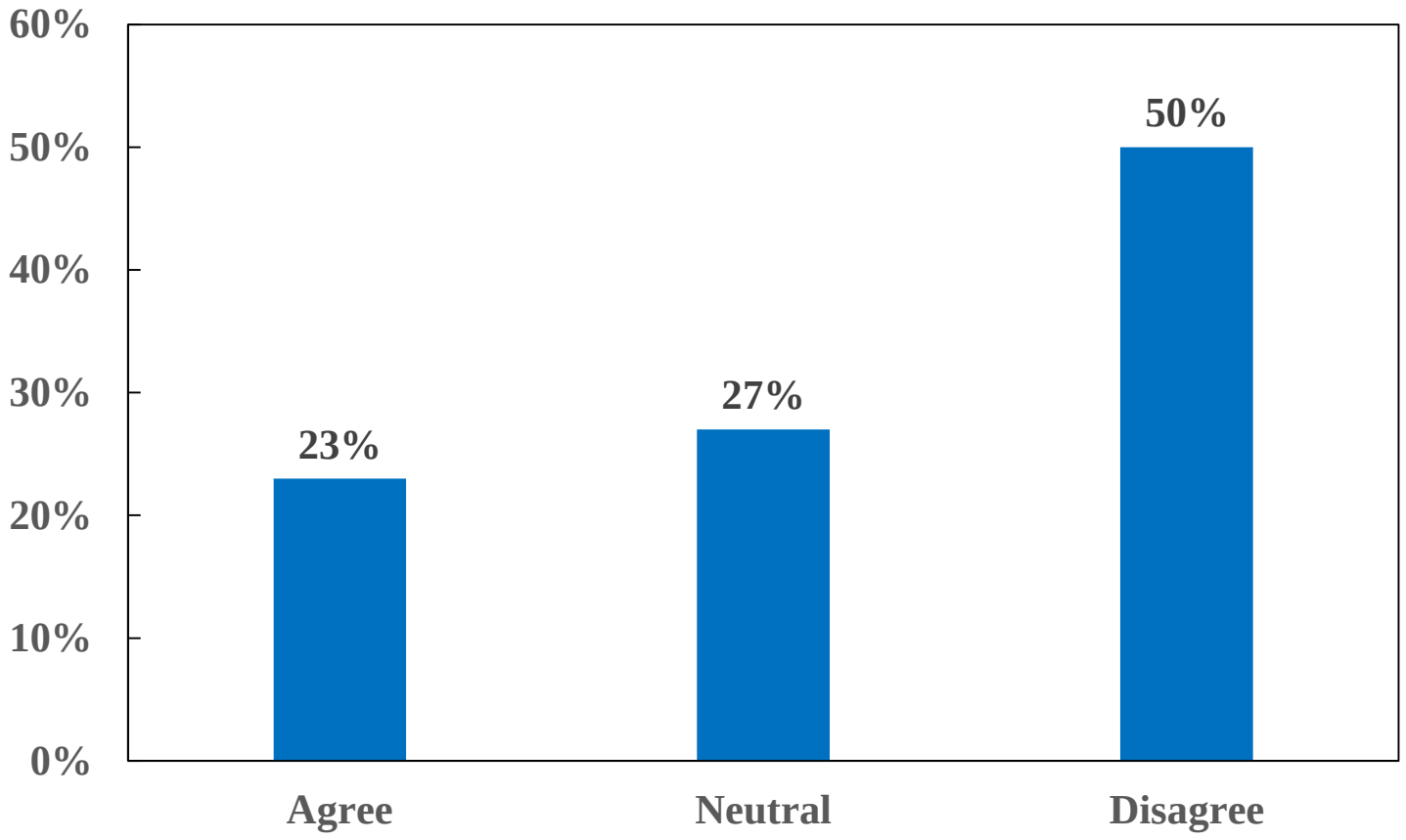
Class time was better spent on active and engaging learning activities rather than traditional lecturing



After participating in this flipped classroom I am more likely to attend other flipped classes offered in the science or engineering programs



I would prefer taking this class completely in person and not doing any of it online



Summary

- Flipped classroom provided more time in class to
  - Solve real-world problems
  - Active student engagement in discussions
- Just-in-time teaching allowed the instructor to spend more time on
  - Unclear concepts, where students need help
  - Important concepts
  - Decreased average error rate from 20% to 8%
- Peer-instruction
  - Enhanced student engagement in the class
  - Frequent testing allowed for longer memory

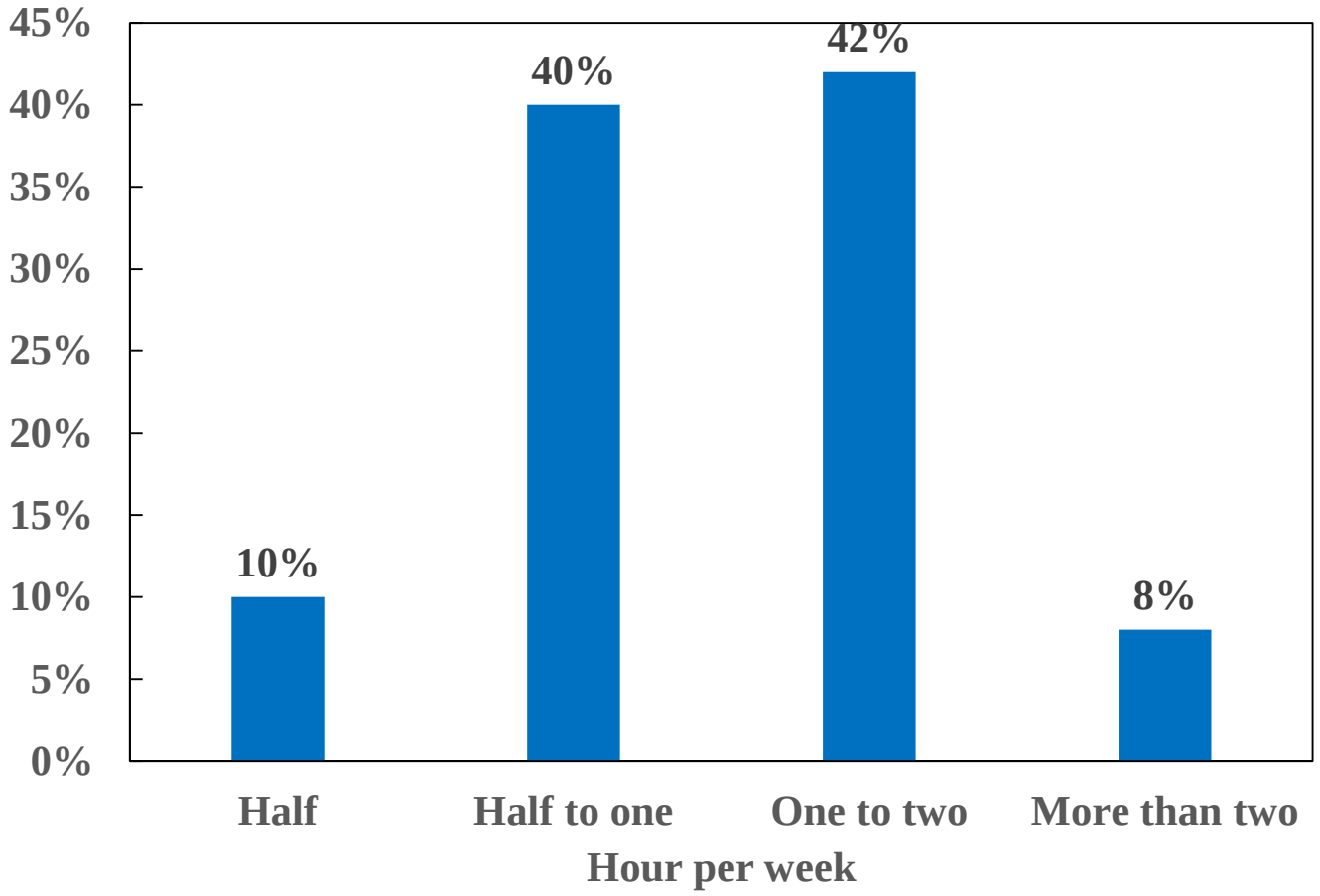
Discussion

- About 25% of students were unsatisfied
- If a student did not pay attention the video prior to the class (but completed the quiz), a flipped classroom environment can have more detrimental effect on learning
- Availability of videos allowed sincere students to have more resources

Questions?

University of Nebraska Lincoln

In a week, how much time do you spend on watching videos outside of class



In a week, how much time do you spend on answering post-video questions outside of class