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Enhancing student engagement in introductory economics with interactive videos and synthesized readings in flipped learning

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Enhancing Student Engagement in Introductory Economics with Interactive Videos and Synthesized Readings in Flipped Learning

A major challenge faced by university economics instructors is to find more time to incorporate active learning into the classroom, which encourages student participation. As a result, more instructors choose to flip their classrooms, in which students are encouraged to perform preparatory reading or watch videos to participate more meaningfully and learn more effectively. This study aims to examine how pre-lecture materials enhance student participation by examining the effectiveness of two types of materials: interactive videos and synthesized readings. The synthesized readings contain essential information extracted from the textbook and is presented in a structured manner with highlighted key points. In the round one study, we found that the videos better prepared students for participation. In the round two study, the effectiveness of readings were greatly enhanced when the synthesized readings are revised according to students' needs. We concluded that readings could be as effective as videos if they were well-designed.

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1. Introduction

A major challenge faced by economic instructors in higher education is finding time to incorporate active learning in the classroom, which encourages student participation, and to explore instructional strategies that enable the development of students' higher-level cognition (Calimeris & Sauer, 2015). To address this challenge, many instructors have started to adopt student-centered approaches to teaching and learning that emphasize student engagement and active learning. One such example is flipped learning, in which students get access to the learning content before class through pre-class learning materials, and in-class time is used for student-centered discussions and high-level topics (Cosgrove & Olitsky, 2020). By inverting the learning process in which students engage in lower levels of cognitive work (remember, understand) outside of class, they are then able to focus on the higher levels (apply, analyze, evaluate) inside the class under the direction of the instructors and the support of fellow students (Yamarik 2019).

Abeysekera and Dawson (2015) broadly defined flipped learning as a set of pedagogical approaches that move information-transmission teaching out of the classroom, use class time for active and social learning, and require students to complete pre- and/or post-class activities to fully benefit from in-class work. Historically, students have been encouraged to read highlighted textbook chapters before class. More recently, information-transmission teaching has been made possible in most cases by technological innovations such as video lectures/tutorials that are rapidly gaining popularity in a flipped classroom setting (Jensen et al., 2018; Das et al., 2019). Other methods of pre-class content dissemination include textbook-style readings, blogs, Google Docs, and Google handouts (Davies et al., 2013).

In examining the use of multimedia for communicating course content, the study by (Miner & Stefaniak, 2018) supported video as a viable teaching resource, with 74% of students indicating videos as being useful for lecture enhancement. Long, Logan and Waugh (2016) found that students had different perceptions of various pre-lecture learning materials, with more students preferring learning via videos to text format materials. In another study, Das et al. (2019) showed that the learning process and student satisfaction were improved by using pre-class learning videos for an undergraduate business information systems management course taught using the flipped approach. The pre-class learning videos used in the flipped class made students feel satisfied with the course through the perceived helpfulness of the learning videos and activities. Students perceived that they were satisfied with the teaching method, knowledge acquired, and learning experience in the course. Student satisfaction with flipping exemplifies the appropriate use of videos for learning and teaching. Based on a large-scale systematic review of the literature on the flipped classroom, Akçayır and Akçayır (2018) found that videos are the most frequently used method of presenting pre-class content, and educators appear to believe that this method will encourage student participation. When coupled with quizzes, videos have been shown to increase student engagement with preparatory class materials. Video-recording technology (e.g., Kaltura & Panopto) has advanced to the point that software now allows the incorporation of quizzes directly into recorded lectures. Given that students benefit from reviewing pre-class materials before a flipped classroom session, it seems that encouraging students to watch pre-class videos by embedding the required quiz questions would improve their engagement and retention as well as their enjoyment.

In addition to student perceptions, the effectiveness of using videos for flipped learning can also be assessed by examining student achievement grades. Multiple studies have reported positive findings. For instance, Calimeris and Sauer (2015) implemented a randomized controlled experience to quantify the educational benefits of flipping the class in an undergraduate introductory microeconomic course. In the flipped class, students experienced the lectures

via instructor-created videos using voiceover PowerPoint slideshows. The standardized exam scores of students who experienced a flipped classroom (treatment group) and the exam scores of those who experienced a lecture-based classroom (control group) were compared. Ordinary Least Squares regression results reflected that the treatment group scored significantly higher (lower bounds of two-thirds to an entire letter grade) on the midterm and final exams than did the control group. The study by Olitsky and Cosgrove (2016) also reported positive findings, where the average student improvement is significantly higher in flipped classes using interactive video lectures and online homework than in non-flipped classes.

In another study, Caviglia-Harris (2016) investigated the effectiveness of the flipped learning method using online videos for an undergraduate economics course. He employed a quasi-experimental design that compared student achievement across three different groups: a 'traditional' undergraduate course, a 'complemented' classroom that combines mini-lectures with assigned online video lectures (sourced from Khan Academy) as homework, and a fully flipped classroom. The findings showed that students in both the 'complemented' and fully flipped classrooms performed significantly better than those in the traditional classroom. Specifically, students scored between 4 and 14 percentage points higher on a set of common questions and on the cumulative final exam. In another quasi-experiment by Yamarik (2019) in an international economics course, two sections were taught using the flipped format where students had to watch pre-lecture videos and complete the online assignments (treatments), and the other two were taught using traditional lectures (controls), with measures of student interest, achievement, and attendance collected. His study found that students in the flipped sections were more interested, engaged, and asked more questions inside and outside of class. This increased engagement with the material could lead to increased learning, as evidenced by the higher homework grades. More recently, Singh (2020) also found that students in the flipped classroom performed better in the final exam and were 1.61 times less likely to fail the introductory economics course than students in the traditional classroom format. The flipped learning format also resulted in better student engagement, greater flexibility, and enhanced student–tutor engagement.

Besides videos, the literature also contains studies that have examined the influence of varied pre-class activities on student exam achievement and compared different pre-class activities. Several authors (e.g., Narloch, Garbin, & Turnage, 2006; Dobson, 2008; Johnson and Kiviniemi, 2009) found that pre-class online quizzes resulted in improved student exam performance compared to those taught using traditional lectures. Vazquez and Chiang (2015) compared the effectiveness of different pre-class materials and concluded that videos have a stronger positive effect on text-based pre-lectures. Students who had access to pre-lecture materials scored significantly higher in comprehension and retention than those with access only to textbooks. Jensen et al. (2018) investigated three methods of pre-class content learning —interactive online tutorials, video lectures, and textbook-style readings on students' learning gains in their final assessments. Their study showed no performance differences between video lectures and readings, suggesting that readings can be as effective as video lectures for out-of-class knowledge transmission. Akcayir and Akcayir (2018) conducted a systematic review of 71 studies on the flipped classroom, to examine its reported advantages and challenges for both students and instructors and noting potentially useful areas of future research on the flipped model's in-class and out-of-class activities. The review showed that the videos and supplementary readings, when used to present pre-class content, were useful to encourage student participation. They highlighted that the preference for videos over readings by most instructors for out-of-class activity stems from students' preference for streaming content over reading text and to allow students to take advantage of the pause, rewind, and fast-forward feature to pace their learning. Akcayir and Acayir (2018) also pointed out that readings should not be overly long as students are less likely to spend many hours completing them.

Taken together, the findings from these studies suggest that flipped learning can be beneficial for several reasons: students can learn at their own pace; access to technology such as videos provides flexibility as to when the students engage with it; and class time is allocated to discussions and group work. By combining content, pedagogy, and technology, the use of videos with embedded quizzes increases students' motivation and improves their learning outcomes. However, most studies have evaluated student performance in flipped learning through exam grades or after-class quiz marks. The effectiveness of pre-class activities on students' engagement during class has received less attention.

This study aims to investigate the use of different pre-lecture materials in enhancing student engagement levels during class time in an undergraduate introductory economics course. When referring to student engagement levels, we are specifically measuring their participation in class discussions and their ability to construct well-articulated and insightful responses. In this study, we tested two methods of pre-class content learning: interactive videos and synthesized readings using essential information extracted from the textbook, which highlights and structures all the key points that will be covered in the lecture.[1] Both types of material include a short quiz at the end to reinforce students' understanding. The study was conducted in two rounds. In round one, the students were divided into two groups with different pre-lecture materials. According to the teaching assistants' records of the frequency and quality of students' class participation, videos achieved an overall higher participation rate than reading. We gathered students' feedback about what they liked and disliked about the pre-lecture materials from round one. Taking students' suggestions into consideration, we improved the synthesized readings and conducted round two with more participants in the following term to investigate the change in the effectiveness of different materials. We concluded that readings could be as effective as videos if they were well-designed.

Class participation is an integral part of university education, where learning takes place through the critical exchange of ideas and engagement of the mind. Students typically feel motivated to participate, ask questions, and contribute to class discussions when they are better prepared. As a result, this paper's contribution is highlighted by the fact that more instructors flip their classrooms to increase students' engagement with knowledge from pre-class activities. Undoubtedly, the instructors need to understand the best method for conveying essential knowledge to students before class. As a result, they would be better prepared to participate in in-depth and interactive class discussions.

The rest of this paper is organized as follows: Section 2 provides research design details. Section 3 reports students' perceptions of different pre-lecture materials. Section 4 discusses the impact of the two pre-lecture materials on student engagement, and Section 5 concludes the paper.

2. Methodology

A. The Course

The course selected for this study is "Economics and Society". It is an introductory-level undergraduate course in economics at a research university in Singapore aimed at year-one students with no prior exposure to university-level economics. There are several sections of this course, with approximately 45 students in each section. The course content covered and all class materials, including the textbook, reading list, and lecture notes, were identical across

[1] To ensure that all students engage in the pre-lecture activities, we have allocated ten minutes at the beginning of each face-to-face lecture for students to review the assigned videos and readings. This dedicated time allows students to access the materials in a structured environment and prepares them to actively participate in the lecture.

all sections. The course content being covered during the 13-week semester is divided into macroeconomics and microeconomics. Class sessions were of 3-hour duration, once per week. This study was conducted in August 2021, when the university resumed face-to-face instruction after moving teaching online the year before due to the pandemic.

Among the 13 lectures, pre-lecture materials were introduced in two lectures. One lecture [**Lecture Mac, the 4th lecture**] discussed a macroeconomic topic--the labor market and the other lecture [**Lecture Mic, the 10th lecture**] discussed a microeconomic topic--indifference curves. Neither topic selected is covered in the General Certificate of Education Advanced Level (GCE "A Levels") Economics.[2]

Indifference curves and the labor market are typically the most challenging topics in university economics courses. Consequently, students need more time to learn and digest. When the two topics were taught in classes without any pre-lecture material, we observed that students' participation decreased compared to other topics. That is, fewer students raised their hands to answer questions, and there was a decrease in the accuracy of their answers. A large proportion of class time was dedicated to explaining the concepts, leaving little time for applications and discussions. Considering this, the two topics of indifference curves and the labor market are ideal for investigating which type of pre-class materials works better to help students learn economics concepts and to increase their engagement in in-class discussions.[3] In addition, in the past few years of teaching this course without pre-lecture materials, we did not observe significant differences in the participation rates for the two topics. Therefore, we believe that the possible changes in participation rates are due to the different pre-lecture materials instead of changing preferences over the two topics.

B. Pre-Lecture Material Preparation

For each topic, two pre-lecture materials were prepared. The first is an interactive video with an embedded quiz that takes roughly ten minutes to complete. The second consisted of synthesized readings using content from textbooks that covered the same content as the videos. [Please see the sample screenshots of each type of pre-lecture material in Appendix A]. Although the traditional teaching style also requires reading outside the classroom, instructors list the relevant chapters in the textbook as the required readings before the lesson. Textbook chapters may include topics beyond the syllabus and redundant information. As a result, not many students are willing to spend hours finishing reading the whole chapter as part of class preparation. This study included synthesized readings that extracted key information from the textbook and organized it in a way that aligned with the lecture content. Completing the readings takes approximately ten minutes for students.

C. Participants and Data Collection

Before the study began, approval was obtained from the university's ethics board. This study was conducted twice in two consecutive academic terms. At the beginning of the academic term, students were informed about the study and signed consent was obtained. Students were also given the option to withdraw from the study at any point.

[2] The General Certificate of Education Advanced Level (GCE "A Levels") is an entry qualification for universities. In Singapore, some students can choose to take Economics as a subject for their GCE A-level examinations in Junior Colleges.

[3] We collaborated with Three Learning Pte Ltd to create two interactive videos featuring embedded quizzes. Due to time and budget constraints from the university, we were only able to include two lectures in this study. However, in future research, we plan to introduce pre-lecture materials in additional lectures to conduct a more comprehensive analysis.

A total of 85 students from two sections of the Economics and Society course participated in the first-round study. In Lecture Mac, Section 1 with 42 students was assigned to the video group with only access to the videos before the lecture, while Section 2 with 43 students was assigned to the reading group with only access to the readings.[4] In Lecture Mic, the two sections switched roles: section 1 was the reading group while section 2 was the video group. As a result, all students experienced different pre-lecture materials. In both Lecture Mac and Lecture Mic, students will go through a pre-lecture activity (either videos or readings) in the first ten minutes followed by a thirty-minute mini-lecture, which is part of the normal lecture. (For ease of reference regarding group assignment in round two, please consult Table 1).

Table 1. Group assignment in two rounds

Round 1 (85 Students in 2 Sections) Fall, 2021	**Lecture Mac**	**Lecture Mic**
Section 1 (42 students)	Video group	Reading group
Section 2 (43 students)	Reading group	Video group
Round 2 (182 Students in 4 Sections) Spring, 2022		
All 4 Sections	Video group	Reading group

At the start of the mini-lectures, the instructor reviewed the contents of the pre-lecture materials. Students were asked to apply what they had learned from the videos or readings to answer practice questions. Subsequently, the instructor introduced the students to high-level topics and their corresponding applications. For example, in Lecture Mac, the videos/readings only cover what determines potential GDP. In the thirty-minute mini-lecture, students would further discuss the forces that make potential GDP grow, and they were invited to draw graphs and present them in class. In addition, a mini-debate was organized on the effectiveness of practical government policies to promote GDP. In Lecture Mic, the pre-lecture material only covers the normal indifference curve when the typical consumer likes both products. Students were encouraged to criticize the assumption and draw indifference curves if the consumer liked one good but hated the other. By doing so, they realized how an economic model simplifies certain aspects of reality to enable an in-depth analysis of a phenomenon of interest while keeping an open mind about its limitations. The instructor also encouraged the students to ask questions after each concept or application. In this mini-lecture, teaching assistants recorded both the frequency and quality of the participation. We measured the frequency in terms of the number of times a particular student raised their hand to answer the questions asked by the instructor or ask questions to the instructor. We measured the quality in terms of the number of questions answered correctly/incorrectly as well as the number of well-articulated and insightful questions and comments.[5]

[4] The university pre-assigned students to different sections at the start of the academic term for this course, while we randomly assigned each section as either the reading group or the video group. To ensure fairness and that students in both video and reading groups had access to all teaching materials, we shared the interactive videos and synthesized readings with all students after the lectures.

[5] In the analysis and reporting of findings, only statistics such as the number of questions and hands raised were collected and used. It is important to note that the teaching assistants did not record the identities of individual students during this part of the study. This was done to comply with the university's Institutional Research Board (IRB) requirements for studies involving human subjects and to ensure that the students' decision to participate in the mini-lecture had no bearing on their grades for the entire course.

We administered online questionnaire surveys to gather students' general feedback on different pre-lecture materials in round one. [6] In the survey, students were asked about their knowledge of the relevant topics before and after going through the pre-lecture materials, their ratings of the pre-lecture materials in terms of (i) helping them to learn effectively, (ii) preparing students to participate in class discussions effectively, and (iii) their preferences for different pre-lecture materials. [Please see the sample survey in Appendix B].

Of the 85 students, 65 completed the post-lecture survey. In round one, more students believed that the videos better prepared them to participate in class, and they also offered many suggestions to improve the synthesized readings. Taking students' suggestions into consideration, we revised the synthesized readings and re-conducted the study in the following term with a larger group of participants.

In round two, 182 students from four sections of the course participated in this study. In Lecture Mac, all students only had videos as pre-lecture materials. In Lecture Mic, all students had access to readings only before class.[7] A total of 100 students completed the post-lecture survey. (For ease of reference regarding group assignment in round two, please consult Table 1).

3. Data Analysis: Students' Perception

A. Round One

In the survey, we collected general feedback on the length and overall satisfaction with different materials. When asked to rate their knowledge change as a result of the pre-lecture materials, the statistical findings revealed that for both groups, before going through the pre-lecture material, more than 75% of the students rated their knowledge to be somewhat or fairly low. However, over 85% of the students considered their knowledge of these topics to be somewhat or fairly high after going through the pre-lecture material. Survey data also shows that more than 87% of the students agreed that the length of the videos/readings was overall okay, they were satisfied or very satisfied with those materials, and those materials effectively or very effectively helped them learn and participate in class discussion. When asked whether the pre-lecture materials made them more confident in class participation and why, 90% of the students believed that it was easier to participate and contribute their ideas with pre-lecture materials.[8] They also reported that they engaged with the instructor more effectively given that they had some knowledge about the topic and knew what content would be covered in class. (Please refer to table 2 for the detailed survey results).

[6] To comply with our university's IRB requirements, the questionnaire survey was designed to be optional and anonymous. This ensures that students who choose not to participate will not be penalized, and it also means that the principal investigators (authors of this paper) will not know which students took part in the survey. To achieve this, we did not collect any personally identifiable information, such as students' names and section numbers, during both rounds of the survey. This approach was taken to prevent the instructor from unfairly penalizing the entire section due to a low survey response rate.

[7] In round 2, our participant sample size increased to 185 students across four sections. To reduce administrative burden, we modified the format by preparing only one type of pre-lecture material and administering one type of survey for all corresponding lectures. For example, all sections only received a video/survey for videos in lecture Mac and a reading/survey for reading in lecture Mic. Despite this, all students experienced both types of pre-lecture materials by the end of the study. To ensure fairness, we also provided the corresponding reading material in lecture Mac and the corresponding video in lecture Mic to students after the lectures, but before asking them to express their preferences between the different types of pre-lecture materials.

[8] Seven out of 65 respondents (10%) felt indifferent in their willingness to participate in class with or without the pre-lecture materials, suggesting that pre-lecture materials do not work for everyone.

Table 2. Detailed survey report

Q1A: Knowledge on the topic before pre-lecture materials	Fairly low	Somewhat low	Average	Somewhat high	Fairly high
	35.29%	**39.72%**	**10.29%**	**8.82%**	**5.88%**
Q1B: Knowledge on the topic after pre-lecture materials	Fairly low	Somewhat low	Average	Somewhat high	Fairly high
	0%	**7.35%**	**7.35%**	**58.82%**	**26.48%**
Q2: Comments on the length of the pre-lecture materials	Too long	Too short		Overall ok	
	10.84%	**1.54%**		**87.62%**	
Q3: How satisfied are you with the pre-lecture materials	Very dissatisfied	Dissatisfied	Satisfied	Very Satisfied	
	0%	**11.38%**	**68.62%**	**20%**	
Q4A: Rate the pre-lecture materials in terms of helping you to learn effectively	Very ineffective	Ineffective	Effective	Very effective	
	3%	**8.46%**	**74.77%**	**13.77%**	
Q4B: Rate the pre-lecture materials in terms of preparing you to participate effectively	Very ineffective	Ineffective	Effective	Very effective	
	1.54%	**11.46%**	**73.23%**	**13.77%**	

More importantly, for question 5, students were asked to share what they liked and disliked about different materials, and for question 8, their preference for videos and readings in terms of better preparing them for class participation. Figure 1 summarizes the data statistics for question 8. Thirty-two students preferred videos, whereas only 18 preferred reading. Seven students were indifferent to the two groups. The key reasons for the students' preferences for different pre-lecture materials are summarized in Table 3.

Figure 1: Students' preference for videos and readings in round one

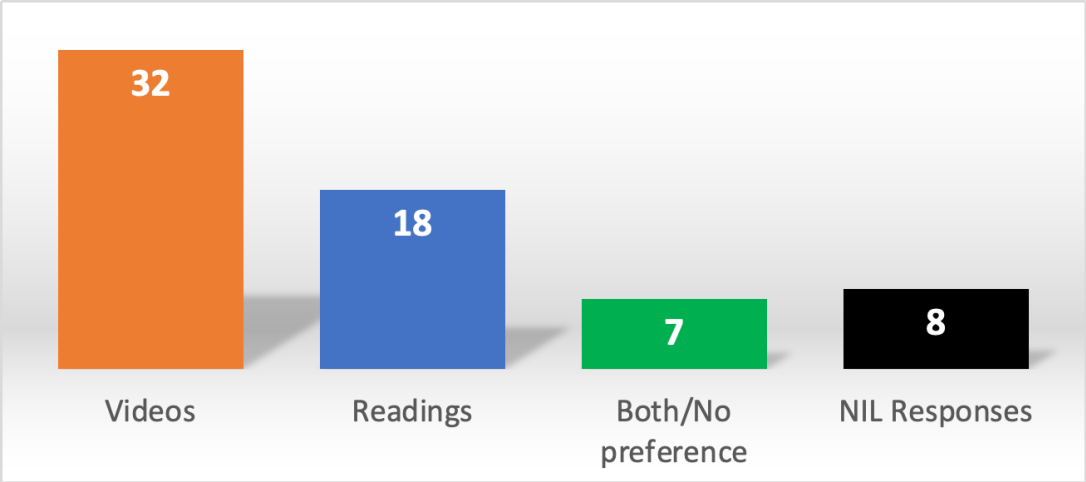


Table 3. Summary of findings on students' preference for videos and readings.

	Reasons for students' preference for videos	**Reasons for students' preference for readings**
Purpose	• Better prepared for class participation	• More suitable for after-class revision • Better in offering a quick recap of the concepts covered in class • Easier to write notes on/capture notes
Pace of Learning	• They are able to replay videos and students can chose to proceed at their own pace • Could be stopped and replayed and allowed students to revisit the topics that they were not sure of	• Stopped at sections that were more difficult to understand while skimming through easier sections • Could read at his/her own pace for readings as compared to having to keep up to speed with the speaker in the video
Learning Preference	• Student is a visual learner • Did not like the readings as the student does not like to read • More entertaining and interactive • Videos better illustrated how to draw graphs in a step-by-step manner • Video was less painful to understand	• Easier to process information in written form • The notes format seemed to be better because the student is an audio learner

Students' Attention	• Zoned out when reading material • Interactivity of the videos-maintained student's attention span better • Reading materials were too wordy and not engaging	• Made students focus better
Structure	• Provided guidance on the concepts in a step-by-step manner	• Easily referenced to know the main ideas. In the videos, all the ideas have equal weight
Illustration of Graph	• Visualized concepts better especially when graphs are involved	• Clear infographics
Concepts Presentation	• Learned better when someone demonstrated and spoke to him/her	• N.A.
Time Saving/ Self-Paced Learning	• Video saved more time	• Using notes over videos saved time • Student could slow down to read at his/her own pace with readings as compared to catching up to the speaker in the video

From Table 3, the following two key factors play important roles in shifting students' preferences towards videos: First, the students believed that the videos maintained their attention better (e.g., "Videos are somewhat interactive, maintaining my attention span better than readings", and "Readings sometimes zone out [sic]"). Second, the participants agreed that the videos better illustrated the graphs (e.g., "Videos were more visual in terms of using more graphs and color coding to illustrate concepts", and "Videos illustrate how to draw graphs step by step"). In addition, videos have gained more popularity than readings because of the unique voiceover and subtitles that present the concepts more clearly (e.g., "When it is hard to concentrate in a short span of time, at least the voice-over gets the content across", "I could learn better when someone demonstrated and spoke to me"). A plausible explanation for students' preference for videos is that they offer a sense of familiarity that closely resembles the experience of learning in a traditional lecture format, viz., a structured and visually engaging presentation of the content (Long et. al., 2016).

Students also shared what they liked regarding the different pre-lecture materials. Table 4 summarizes the key points that will help instructors understand the best method of conveying essential knowledge to students before class and to better design different types of pre-lecture material.

Table 4. Summary of what students liked about the pre-lecture materials

	Videos	Readings
Including quiz	• The quiz at the end helped the student gauge if he/she had grasped the concepts correctly and helped refresh concepts they already knew	• Short quiz after the reading helped with active recall • Clearly showed examples and even the use of quizzes helped out
Short and concise	• Videos were short and easy to understand	• Short and concise
Including graphs	• Good diagrams of graphs and clear concepts	• Infographics were clear. Graphs were useful to help students better visualize
Voiceover and subtitles	• Voiceover and subtitles helped keep students' attention	N.A.
Interactive and well-paced	• Liked the material as it was engaging and interactive • Well-paced and allowed students to revisit topics they were unsure of	N.A.
Point format	• N.A.	• Point format reading which was easier to refer to in class
Provides extra information	• Provided extra information and went more in-depth so we could have a better understanding of a particular topic	• Informative

Students cited four key aspects of the pre-lecture materials: 1) the quiz for concept recall and reinforcement (e.g., " liked the short quiz after the reading, it helps with active recall and gauge whether I have grasped the concepts"), 2) the brevity and conciseness of the videos and readings (e.g., "It was short and concise allowing me to absorb the points better"), 3) the graphs for improved visualization (e.g., "I liked that there were graphs provided in order to help me better visualize"), and 4) the interactivity of the content (e.g., "I enjoyed the content as it was interactive, which enhanced my learning").

Students also provided suggestions regarding improvements to the videos and readings. For the videos, some students suggested having a summary at the end before the quiz so that they could download and use it for future revision. Other students recommended allowing students to control the speed of the video at different rates of learning. Students provided several suggestions for the synthesized readings. They believed that additional applications or examples could be added to their reading (e.g., "I didn't really like the readings as they were too

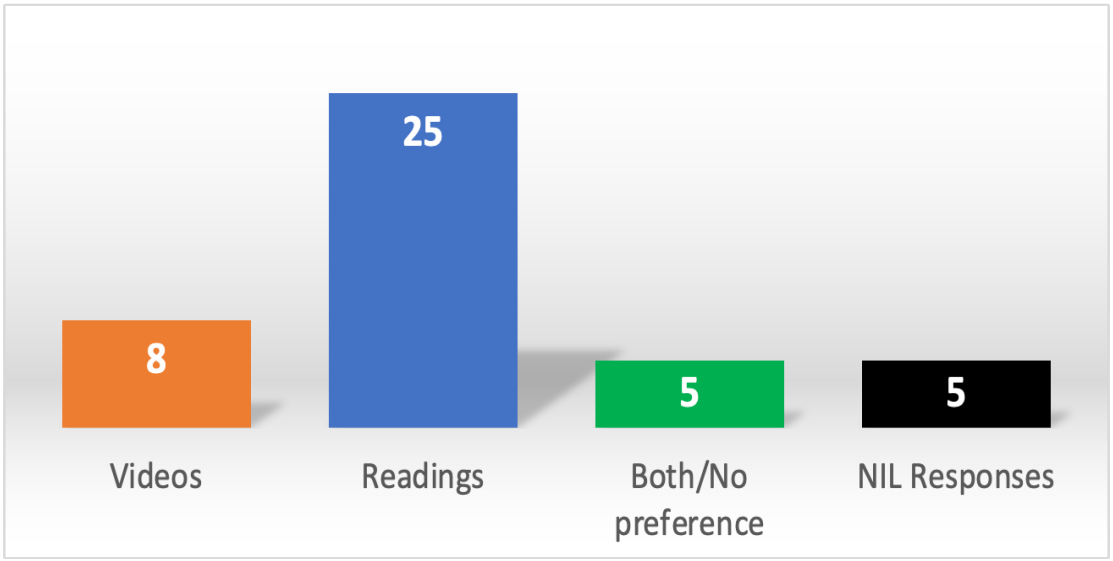
informative. Perhaps adding applications or examples in the reading would help me to better understand the topic and how I can apply it."). They also suggested redesigning the readings in a better manner, highlighting all key points and formulas (e.g., "These readings were extremely wordy. While they were informative and are good resources, the points could be laid out in a more reader-friendly way, such as key points, formulae should be highlighted or starred in the material."). Finally, students recommended offering both materials to choose from based on their preferences (e.g., "I think both would be great as they complement each other", "I feel that both need to come together [sic] students can refer to the notes (for revision) after watching the video").

B. Round Two

Based on the student suggestions received regarding the synthesized readings, we made several improvements to the pre-lecture material. Specifically, the following changes were implemented. First, we further shortened and reorganized the readings, incorporating additional bullet points that succinctly summarized the key ideas relevant to the lesson topic. As an illustration, for the Mic lecture in round one, the readings spanned five pages, which we were able to condense to three pages in round two. Second, all key points were highlighted, such as definitions and main conclusions. Third, applications or examples were added to every concept to demonstrate the concrete applications of the concepts. We conducted a revised round--round two, in another semester, with four sections of students in the same course. In round two, all students are in the video group in Lecture Mac with only videos as pre-lecture materials. They all belong to the reading group in Lecture Mic with improved and revised readings before class.

As shown in Figure 2, for students who answered the last question in the survey, "Pre-lecture readings or videos, which can better prepare you for class participation and why?", 25 out of 43 students chose pre-lecture readings over videos, a much higher percentage than round one, with only 18 out of 65.

Figure 2: Students' preference for videos and reading in round two



From the students' feedback, we summarized a few key reasons that may tip the balance to the pre-lecture readings. First, 37.2% of the respondents believed that reading offers easier references (e.g., "I can always refer to the readings and identify where exactly I last saw the explanation of a concept through briefly browsing through the document. Whereas, for videos, it is tougher to just roughly scan through what I have just learned and remember at which part of the video where something was taught", "It was inconvenient to replay the whole video to rewatch a small section."). Second, 4.7% of the students agreed that reading may save time in lecture preparation compared to videos (e.g., "It is much more time-efficient, and I personally like to read more than watch.", "If I did not catch what the video was saying, I had to rewind or try to pinpoint the specific spot in the video which might waste some time."). Third, 16.3% of the responses mentioned that readings were more personalized in the sense that students could read at their own pace (e.g., "I am able to read the notes at my own pace and if I do not understand I can just read it again whereby I have to pause the videos to take notes", "I had more freedom to pace myself at a comfortable speed."). Finally, 4.7% of the students found that reading offers an easier assessment. (e.g., "I prefer it to be in note form than videos because I can access the learning materials at any time").

4. Data Analysis: Effectiveness of Different Pre-lecture Materials on Student Engagement

Teaching assistants measured class participation in every lecture in the course, including those without pre-lecture videos. In other normal lectures without pre-lecture videos/readings that last for a much longer time and with a much larger number of questions, it is difficult for teaching assistants to note both frequency and quality. As a result, teaching assistants measured only frequency. Table 5 reports the students' average class participation rate: the number of students who raised their hands to answer the question. For normal lectures without pre-lecture material, on average, 4.6 out of 45 students attempt to participate and contribute. This average rate was calculated according to the records by teaching assistants over the semester, across all sections, and in all normal lectures without pre-lecture material. Our study revealed that both videos and readings when used as pre-lecture materials, increased students' class participation and hence engagement levels. This was evident from students' class participation records that showed a larger percentage of students raising their hands during class discussions. This finding is mirrored in the systematic review by Akcayir and Akcayir (2018), who highlighted that the videos and supplementary readings, when used to present pre-class content, were useful in encouraging student participation. Students could review the videos and readings at their own pace, leading to better reinforcement of concepts.

Table 5. Students average class participation rate for rounds 1 and 2

	Lecture with video preparation	**Lecture with reading preparation**
Round one	12.3 out of 45	8.7 out of 45
Round two	12.8 out of 45	12.3 out of 45

Noticeably, certain students who were typically less active in class discussions during typical lectures demonstrated an increased willingness to participate by raising their hands. This group included students new to economics and those who were naturally reserved or introverted. A plausible explanation for this observation could be that pre-lecture preparation used for flipped learning helps to reduce these students' anxiety, providing them with a sense of emotional safety (see also the study by Steen-Utheim & Foldnes, 2018). As a result,

the utilization of pre-lecture materials enhanced the motivation of less participative students, leading to greater engagement and participation during lecture class discussions. Conversely, highly engaged students or those with extensive background knowledge in economics may have derived less benefit from the pre-lecture materials.

In round one, lectures with students in the video group had an overall higher participation rate than lectures with students in the reading group. This finding indicates that videos, when used for pre-lecture preparation, can enhance student engagement levels. Although students recognized that they could adjust their pace of learning for both videos and readings, most students preferred learning via videos when presented with the same content. The dynamic and interactive nature of the videos to teach graphical concepts was able to better capture students' attention and improved students' learning, owing to the introduction of the concepts in a structured manner (Long et al., 2016; Das et al., 2019). Another probable reason for students being more prepared for class when videos are being used as pre-lecture materials is that students can take advantage of the pause, rewind, and forward features in videos to review and reinforce concepts, and their learning preferences for streaming lecture content over reading text which is often regarded by students as being 'monotonous' (Akçayır & Akçayır, 2018).

In contrast, we found similar class participation rates for students in both the video and reading groups in round 2 suggesting that both videos and readings when used for pre-lecture preparation can enhance student engagement levels. Improvements made to the readings based on student suggestions in round 1 may have given rise to this observation. A plausible explanation for this observation is that students appreciated the shortened readings, reorganization of the key concepts using bullet points and highlighting, and inclusion of more applications and examples. Our study also supported the finding of Jensen et al. (2018), who observed no performance differences between the two on students' performance in their final exams. Our study also suggests that reading can be as effective as video lectures for enhancing engagement.

5. Conclusion

This study summarizes the use of two different types of pre-lecture materials in enhancing student engagement levels during class time in an undergraduate introductory economics course. From the instructor's perspective, videos, compared to synthesized readings, can increase student participation. However, it is worth noting that creating videos is a more time-consuming process that requires extensive preparation and development efforts. On the other hand, the effectiveness of readings can be improved by customizing them to meet students' needs, such as by including highlighted key points and relevant real-world applications. Students may also show a preference for readings if designed interactively and engagingly.

In this study, the completion rates for pre-lecture materials were 100%, since ten minutes was given during class time to make sure all students had gone through the pre-lecture materials. This dedicated time allows students to access the materials in a structured environment and prepares them to actively participate in the lecture. We believe that our findings can be generalized to similar undergraduate introductory economics courses taught in a flipped learning setting if the instructors can ensure that the students complete the pre-lecture materials before class. For instance, instructors could increase the accountability of students by making the completion of pre-lecture materials compulsory or linking it to their final grades as an effort component.

We believe this study's results will contribute to the literature by extending the existing literature discussion to the impact on student engagement. The results can provide

recommendations for the best pre-lecture educational method for any instructor trying to flip their classroom or increase student participation in class. These results may lead to future research. For example, the results could be applied to other courses at different levels or disciplines. Moreover, it will be better to give students access to both types of material and allow them to choose based on their learning preferences.

As noted earlier, our study focused on investigating whether pre-lecture materials enhanced student engagement during class time, as reflected by their participation frequency. While we found that both pre-lecture materials can increase participation, we did not investigate the effects of pre-lecture materials on student academic performance. However, we acknowledge that the relationship between pre-lecture materials and student academic performance is an important area of investigation. Therefore, we suggest it as a potential future direction of the study. For instance, a future study could examine whether the use of videos or readings as pre-lecture materials has a significant impact on student grades, test scores, or other measures of academic performance. It would also be interesting to investigate whether any moderating variables influence this relationship, such as students' learning styles or motivation levels.

Another potential area for future study is to examine the quality of student participation in class discussions, beyond just their frequency of contributions. For example, future research could also explore whether the use of pre-lecture materials affects the depth, relevance, or coherence of students' comments during class. Such investigations could help instructors understand not only how to increase student participation but also how to promote more meaningful and effective class discussions.

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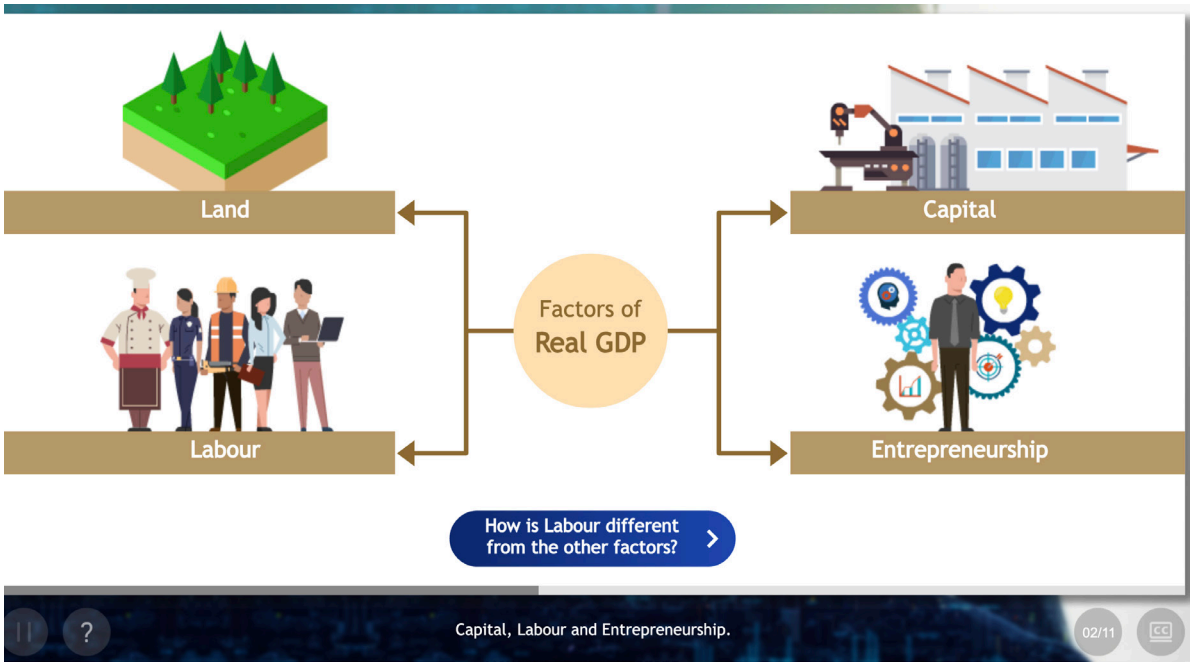
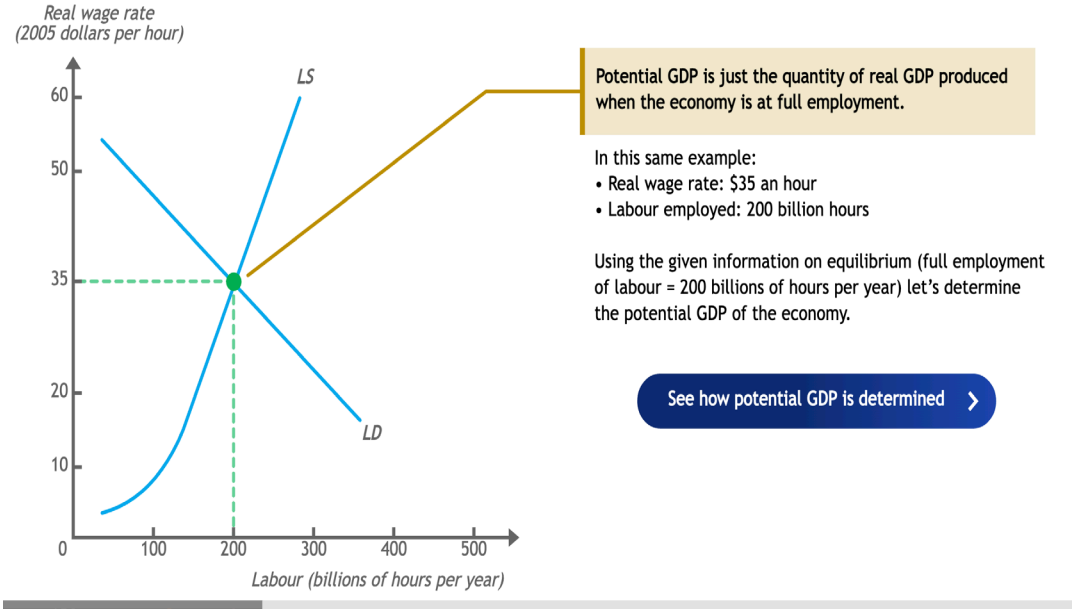
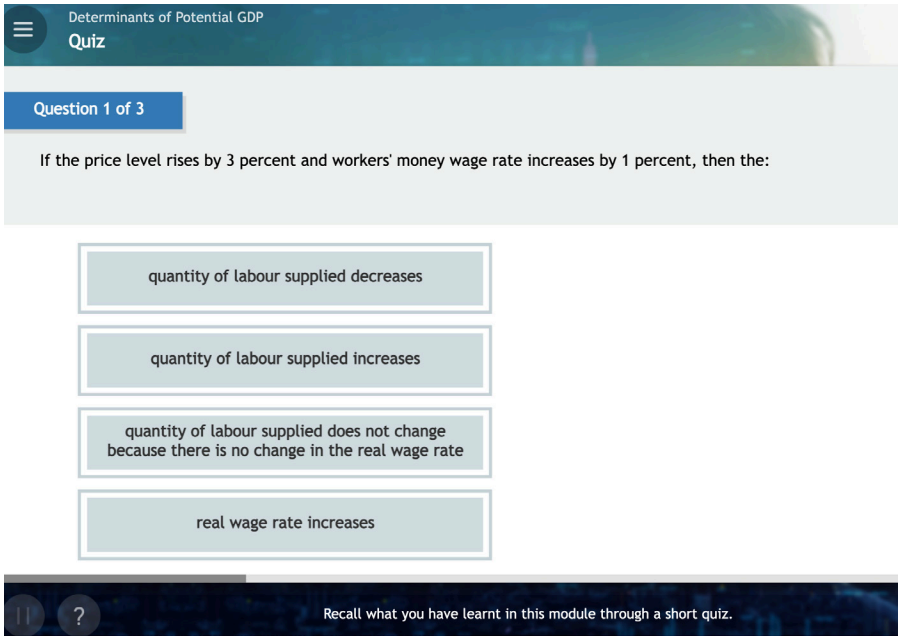
Appendix A

Sample screenshots of interactive videos







Sample screenshots of readings

1. In this self-learning section, you will learn what determines potential GDP, and we will then cover "what makes potential GDP grow" and "how to increase the sustainable rate of economic growth" in class later.

2. First of all, what resources do we need in production in real life? Labor, capital, land and entrepreneurship produce real GDP, and the productivity of the factors of production determine the quantity of real GDP that can be produced.

   However think about it, the quantity of land is fixed on any given day, the quantities of entrepreneurial ability and capital are also fixed and their productivities are given. The quantity of labor employed is the only variable factor of production that can be changed in the short run.

3. Let us define what is potential GDP. Potential GDP is the level of real GDP when the quantity of labor employed is the full-employment quantity. To determine potential GDP, we use a model with two components. One is the aggregate labor market to know the full-employment quantity of labor, the other is the aggregate production function to know what we can produce at this full-employment quantity of labor.

Quiz

If the price level rises by 3 percent and workers' money wage rate increases by 1 percent, then the ( )

A. quantity of labor supplied decreases.
B. quantity of labor supplied increases.
C. quantity of labor supplied does not change because there is no change in the real wage rate.
D. real wage rate increases

Appendix B

Post-lecture Survey

Q1. Please rate your knowledge of the labor market/Indifference curve before/after going through the pre-lecture materials

Fairly low

Somewhat low

Average

Somewhat high

Fairly high

Q2 Overall, what are your comments on the length of the videos/readings?

Too long

Too short

Overall OK

Q3 Overall, how satisfied are you with the pre-lecture materials?

Very dissatisfied

Dissatisfied

Satisfied

Very satisfied

Q4 Overall, how would you rate the pre-lecture materials in terms of helping you to learn effectively & preparing you to participate in class discussion effectively?

Very ineffective

Ineffective

Effective

Very effective

Q5 For the pre-lecture materials, what did you like or not like about them?

Q6 Did the pre-lecture materials help you to learn and why?

Q7 Did the pre-lecture materials make you more confident in class participation and why?

Q8 Pre-lecture readings or videos, which can better prepare you for class participation and why?