

Development of Calculus Learning Videos as Learning Mitigation Efforts During Covid-19 Pandemic

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ABSTRAK

Penelitian ini difokuskan pada media pembelajaran berupa video asynchronous sebagai upaya mitigasi pembelajaran selama masa pandemi Covid-19 pada mata kuliah Kalkulus 1 di Program Studi Statistika Universitas Islam Indonesia (PSS UII). Tujuan dari penelitian ini adalah untuk mengevaluasi media pembelajaran yang diberikan selama pandemi Covid-19, pada mata kuliah Kalkulus 1 di PSS UII. Sumber data yang digunakan adalah data primer dari skor Ujian Akhir (UA) Kalkulus 1 sebelum pandemi (tahun akademik 2018/2019 dan 2019/2020) dan saat pandemi (tahun akademik 2020/2021), serta kuesioner yang dibagikan kepada mahasiswa di PSS UII. Metode analisis yang digunakan adalah uji Kruskal Wallis, uji Mann-Whitney, Importance-performance analysis (IPA), dan text mining. Diperoleh hasil bahwa terdapat perbedaan nilai UA untuk setiap tahun akademik. Nilai rata-rata dan median tertinggi UA ada pada tahun ajaran 2020/2021. Hal ini menunjukkan bahwa metode pembelajaran online melalui video pada mata kuliah Kalkulus 1 tahun ajaran 2020/2021 berhasil meningkatkan nilai UA mahasiswa. Berdasarkan hasil IPA, nilai rata-rata Customer Satisfaction Index (CSI) adalah 97,97%, dengan rincian 50% pada pencapaian prioritas, 33,33% pada prioritas utama, dan 16,67% pada prioritas rendah. Text mining terkait media pembelajaran menunjukkan bahwa video yang disediakan mudah dipahami, menarik, dan jelas dalam pembahasan materi.

ABSTRACT

This research is focused on learning media in the form of asynchronous videos as a learning mitigation effort during the Covid-19 pandemic for Calculus 1 subject. The objectives of this study were to evaluate the learning media provided during the Covid-19 pandemic. The data sources used are primary data from Final Exam (FE) scores before the pandemic (academic year 2018/2019 and 2019/2020) and during the pandemic (academic year 2020/2021), as well as questionnaires distributed to students. The analytical methods used are Kruskal Wallis test, Mann-Whitney test, Importance-performance analysis (IPA), and text mining. The results showed that there were differences in FE scores for each academic year. The highest average and median scores of FE are in the 2020/2021 academic year. This shows that the online learning method through videos in the Calculus 1 subject for the 2020/2021 academic year has succeeded in increasing scores of FE student. Based on the results of IPA, the average value of the Customer Satisfaction Index (CSI) is 97.97%, with details of 50% on priority achievement, 33.33% on top priority, and 16.67% on low priority. The results of text mining related to learning media show that the videos provided are easy to understand, interesting, and clear in explaining the material.

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Introduction

The coronavirus (Covid-19) pandemic has resulted in significant changes in various countries, including Indonesia. This pandemic started from the novel coronavirus in Wuhan (Abdulmir & Hafidh, [2020](#); Addi et al., [2020](#); Aljofan & Gaipov, [2020](#); Sorooshian, [2020](#)) and then turned into a global disaster and even gave shockwaves throughout the world. Based on the World Health Organization (WHO), Indonesia is in the top 20 countries affected by the Covid-19 pandemic (WHO Coronavirus (Covid-19) Dashboard, [2021](#)). Even today, there are still many cases in Indonesia. The lack of public awareness regarding health protocols is one reason why there are still many Covid-19 cases in Indonesia.

The existence of this pandemic has an impact on crises in various aspects such as economic, social, cultural, and even educational aspects. The crisis caused by the Covid-19 pandemic is also different from the crisis from previous years, both in terms of causes, scope, and severity (Reinhart, [2020](#)). The impact of the Covid-19 pandemic is likely to be more profound on mental health and well-being over the longer term (Holmes *et.al.*, [2020](#); Hotopf *et.al.*, [2020](#)). In Indonesia itself, when viewed from the economic aspect, the pandemic resulted in a decrease in demand from consumers, especially in three sectors: (1) accommodation and food and drink, (2) transportation and warehousing, (3) other services (Badan Pusat Statistik, [2020](#)).

Meanwhile, when viewed from the aspect of education, the Covid-19 pandemic is a big challenge for the education system. In fact, at the beginning of the Covid-19 pandemic, many countries closed schools, for example China in February 2020 which closed schools and was then followed by other countries (Schleicher, [2020](#)).

Previously, learning was carried out face-to-face between educators and students, this pandemic has caused learning to shift through online learning. These are the drastic changes in the aspect of education. During the spread of this deadly virus, online learning is indispensable (Basilaia, [2020](#)). Most forms (online learning, blended learning, open learning, web-based learning, and computer-mediated learning) generally use computers connected to the internet such that they can be accessed from anywhere, anytime, and under any conditions (Cojocariu *et.al.*, [2014](#)). In this case the rapid development of technological advances will make the online learning education easier as has been highlighted by (McBrien *et.al.*, [2009](#)).

Online learning is defined as a synchronous or asynchronous learning experience using various devices (such as laptops, tablets, mobile phones, etc.) with internet access. Therefore, students can learn independently to learn and interact with educators (Singh & Thurman, [2019](#)). Synchronous learning is learning that students attend in real-time interaction between educators and students, and there is the possibility of direct discussion. It provides many opportunities for social interaction (McBrien *et.al.*, [2009](#)). While in asynchronous learning, learning is available in a separate system. The discussion process is also not possible directly (Littlefield, [2018](#)).

This drastic change has an impact that is not simple, not only from the student side but also has an impact on educators and the existing support system of each institution. In terms of demographics, Indonesia is a country that has diverse demographic forms (some are in the city center, and some are in remote villages) so that not all regions can access the internet with uniform quality. Furthermore, it is not uncommon for online learning to be challenging to adapt due to internet network constraints and wasteful data packets (Angelica *et.al.*, [2021](#); Sadikin & Hamidah, [2020](#); Siahaan, [2020](#); Sulata & Hakim, [2020](#); Suni Astini, [2020](#)).

From the educator's perspective, the existence of this pandemic is a challenge. This is because educators must adapt to conditions that may not have been imagined before, namely the process of delivering material, the process of evaluating learning, even the process before the implementation of online learning. On the other hand, due to limitations in online learning such as signals, fluency of communication, ease of delivery, an effort is needed from an educator to prepare a concise learning process but still maintain the content of the material to be given. This is so that the quality of education in online learning can still be improved. Furthermore, online learning is expected for students to remain competent in mastering competencies independently so that active learning will be formed, and the competencies mastered by students are more contextual (Syarifudin, [2020](#)), and are even expected to be bolder in expressing their ideas (Handarini & Wulandari, [2020](#)).

Calculus I is one of the subjects at Statistics Study Program, Universitas Islam Indonesia (SSP UII). It is a compulsory subject for the first-year students. It is one of the fundamental knowledge areas for students who would like to study in almost every department at higher education. Students' understanding toward Calculus I will help them to understand other mathematics-statistics related subjects. Therefore, at SSP UII, Calculus I is a very important subject.

Calculus I is considered as the theoretical subject, which is best to be taught in the offline method. Because of the pandemic, at SSP UII, the teaching method for all subjects is shifted from offline method to the online one. There are concerns that this online method will affect students' interest in learning Calculus I, students' ability to understand the content of Calculus I and the Final Exams (FE) scores of Calculus I. Which at the end it will affect their studies at SSP UII. Therefore, it is important to investigate the impact of the online learning method in Calculus I to find out the best way of teaching delivery methods during the pandemic.

In this paper, the research focuses on the alternatives prepared by lecturers to optimize learning limitations with the existence of learning videos, as a learning mitigation effort during the Covid-19 pandemic for Calculus I subject. The Calculus I learning video can be used by students to prepare, understand, and even evaluate the given material. The availability of the video does not mean to replace the learning process, but to support the learning process on Calculus I subject.

The scenario is the students will have to learn the material for each meeting before the synchronous class to be carried out. We assumed this will help students to understand better the material on the subject. Students will be well prepared and gain the pre knowledge on the subject before the class. Then, during the synchronous learning process, students have plenty of time to reconfirm their knowledge with the lecturer and have more time to discuss. The discussion is designed to overcome the obstacles or problems from the material on the Calculus I learning video, where the lecturer implementing the Student Teams Achievement Divisions (STAD) learning method in the class. Implementing the learning video means the synchronous learning time can also be shortened such that the learning process does not cause boredom and fatigue for lecturer and students, especially in mathematics education learning process.

Methods

The objectives of this study are: (1) to find out how significant the impact of the online learning process is, especially for Calculus I subject, (2) to measure the Customer Satisfaction Index (CSI) of Calculus I students about the implemented learning media, and (3) to evaluate the learning media provided during the Covid-19 pandemic.

The research was carried out from September 2020 to January 2021 at the SSP UII. The object population of this research is all students at the SSP UII. The research object sample used is all the first-year students of the SSP UII before the Covid-19 pandemic (academic years 2018/2019 and 2019/2020) and during the Covid-19 pandemic (academic year 2020/2021). The reason, why we use the two academic

years before the pandemic, is because it is taught by the same lecturer in the academic year 2020/2021.

The structure of the research instrument used was in the form of test instruments and questionnaires. The test instrument is in the form of questions based on the Course Outcomes (CO) of Calculus I subject. The questionnaire instrument is an open and closed questions using a Likert scale to evaluate the learning media. Therefore, sources of data used are primary data obtained from the Calculus I FE scores which is collected from SSP UII lecturer archives and questionnaires distributed to 2020/2021 academic year students. The research variable used in this study is the FE score of Calculus I subject in the academic year 2018/2019, 2019/2020, and 2020/2021.

The data analysis techniques used in this research are descriptive and inferential. Descriptive data analysis is used to describe and visualize the students' understanding about Calculus I and the results of the questionnaire. On the other hand, the inferential analysis is used to measure the impact of online learning through the learning video toward students' understanding about Calculus I at SSP UII.

The descriptive statistics used are central tendency such as: mean, median, minimum, and maximum for the FE score. Meanwhile, for the questionnaire, we used the Importance-Performance Analysis (IPA) Visualization, Customer Satisfaction Index (CSI) and text mining. The inferential analysis used in this research is the Kruskal-Wallis and Mann-Whitney statistical tests. Kruskal-Wallis is a one-way analysis of variance by ranks, where the initial hypothesis (H_0) is that several samples come from the same population (Daniel, [1990](#)).

The assumptions for using the Kruskal-Wallis test include: (1) data consists of k random samples with sizes n_1, n_2, \dots, n_k (2) observations are independent, (3) variables of concern are continuous, (4) measurement scale minimally ordinal, (5) the distribution function of the two populations is only separated by the location of the parameter. The hypothesis of the Kruskal-Wallis test, H_0 : the distribution function of the k population is identical/same ($M_1 = M_2 \dots = M_k$) and the alternative hypothesis (H_1): there is at least one $M_i M_j$ where $i \neq j$ and $i, j = 1, 2, \dots, k$.

The statistical procedure of the Kruskal-Wallis test is as follows. (1) Combine all sample data to be as many as $n_1 + n_2 + \dots + n_k = N$ observations. (2) Rank each observation from the smallest to the largest. If there are ties (the same value), give it a middle rank (mid-rank). (3) Count the number of ratings for each sample, expressing each as R_i . (4) Kruskal-Wallis test statistics are presented in Equation 1.

$$H = \frac{12}{N(N+1)} \sum_{i=1}^k \frac{R_i^2}{n_i} - 3(N+1) \quad (1)$$

R_i is the number of ratings for the i^{th} sample, n_i is the number of observations in the i^{th} sample, and N is the total observations (Hecke, 2013). If there are ties, then the test statistic needs to be corrected by the factor in Equation 2.

$$1 - \frac{\sum T}{N^2 - N} \quad (2)$$

$T = t^3 - t$, t is the number of ties so that the Kruskal-Wallis test statistic is corrected to Equation 3.

$$H_c = \frac{H}{1 - \sum T/N^3 - N} \quad (3)$$

Then the fifth step is that decision making is divided into two things, namely: (a) if it involves three sample/treatment groups ($k = 3$) and each sample group consists of five or less observations, then use the Kruskal Wallis table. Reject H_0 if H or $H_c > H_\infty$ and (b) if point a cannot be used, then use the Chi-Square table. Reject H_0 if H or $H_c > \chi^2_{(\alpha, k-1)}$.

If the results of hypothesis testing on the Kruskal-Wallis test obtained a decision to reject H_0 then it can be concluded that there is at least one $M_i \neq M_j$ where $i \neq j$ and $i, j = 1, 2, \dots, k$ or in other words, there are differences in the results of the different treatments. given. To find out which treatment gives different results, it is necessary to carry out further tests, namely the Mann-Whitney test.

The Mann-Whitney test is one of the nonparametric tests to analyze data because there are two different treatments in two independent sample groups. The assumptions for using the Mann-Whitney test include the following, (1) the data are random samples X_1, X_2, \dots, X_n originating from population 1 with a median M_x , and random samples Y_1, Y_2, \dots, Y_n originating from population 2 with a median M_y . Where the values of M_x and M_y are unknown, (2) The two samples are independent. (3) The random variable is continuous, (4) The data measurement scale is at least ordinal, (5) The distribution function of the two populations is only separated by the location of the parameters. The hypothesis of the Mann-Whitney test, H_0 : the distribution function of the two populations is identical/same ($M_x = M_y$) and H_1 : the distribution function of the two populations is not identical/same $M_x \neq M_y$.

The Mann-Whitney test procedure is as follows. (1) Combine the two-sample data. (2) Rank each observation from smallest to most significant value. If there are ties, then give a middle rank (mid-rank). (3) Add up the rankings of population one and express the results with S . (4) The Mann-Whitney test statistic is presented in Equation 4.

$$T = S - \frac{n_1(n_1 + 1)}{2} \quad (4)$$

H_0 is rejected if $T < w_{\alpha/2}$ or $T > w_{1-\alpha/2}$, where $w_{1-\alpha/2} = n_1 n_2 - w_{\alpha/2}$. If the sample is large ($n_1, n_2 > 20$), it can be approximated with a normal distribution with Equation 5 (if there are ties) and Equation 6 (if there are no ties).

$$Z = \frac{T - \frac{(n_1 n_2)}{2}}{\sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12} - \frac{n_1 n_2 (\sum t^3 - \sum t)}{12(n_1 + n_2)(n_1 + n_2 - 1)}}} \quad (5)$$

$$Z = \frac{T - \frac{(n_1 n_2)}{2}}{\sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}}} \quad (6)$$

H_0 is rejected if $Z_{hit} > Z_{\alpha}$ where n_1 is the number of samples in group 1, n_2 is the number of samples in group 2, and t is the number of ties (Daniel, [1990](#)).

Apart from the value of learning outcomes, the level of conformity is also measured using IPA. IPA is an analysis used to investigate the importance (importance) and performance (performance) of an action (Ha *et.al.*, [2019](#)). The IPA will produce four (4) quadrants, namely: (1) maintain achievement (keep up the good work), (2) top priority (concentrate here), (3) low priority (low priority), (4) excessive (possible overkill) (Keith & Boley, [2019](#)). In addition, the IPA also calculates the level of suitability of the respondent, which is the comparison between performance and interests written in equation 7 (Herman, [2020](#)).

$$LC_i = \frac{X_i}{Y_i} \times 100\% \quad (7)$$

LC_i : level of conformity, X_i : score of performance appraisal, and Y_i : score of importance assessment.

After the entire series of learning processes are implemented, the students will be given two questionnaires, namely: (a) a questionnaire to measure the advantages and disadvantages of learning media. It is analyzed using the text mining. Further, the sentiment analysis is used to do the word cloud visualization. The word cloud is used because it can visualize the description of the frequency of words in an exciting but informative form (Pradana, [2020](#)), and the R programming language is used for word cloud visualization because some of the advantages of R include programmability, multi platforms, and portability (Rosadi, [2016](#)). (b) a questionnaire to measure how much influence the learning media has on the suitability of learning mathematics-calculus for the first-year students. The questionnaire contains six aspects measurement in the IPA, namely: lecture material was delivered well through video, visual display of video, the clarity of video audio,

the back sound in the video is related to the spirit of paying attention to the material, the clarity of examples solution in the video, understanding of the material in the video.

Result and Discussion

The first result is about the normality data where the hypothesis null statement is H_0 : the data is normally distributed. Based on the Shapiro-Wilk test, Table 1 shows that data are not normally distributed. Therefore, we use the Kruskal-Wallis test.

Table 1. Normality test results.

Data Source	α	P-Value	Decision	Conclusion
Residual model	0.05	1.387e-13	Reject H_0	Data is not normally distributed

The Kruskal Wallis test hypothesis statement is H_0 : the distribution function of the three populations are identical/same, or in other words, there is no difference in the FE median value in the three academic years. The Kruskal Wallis test provides the $p - value = 2.2 \times 10^{-16} < 0.05 = \alpha$. Hence it is concluded that there is at least one academic year where the FE median is different from the others. The Mann-Whitney test results can be seen in Table 2. It reveals that the median of FE of the three academic years are different.

Tabel 2. The results of the Mann-Whitney Test

Data source	Academic Year	α	P-Value	Decision	Conclusion
Result of final exams	2018/2019 and 2019/2020	0.05	0.000	Reject H_0	There is a difference in the median final grades of the FE in the 2018/2019 and 2019/2020 academic year.
	2018/2019 and 2020/2021	0.05	0.000	Reject H_0 .	There is a difference in the median final grades of the FE in the 2018/2019 and 2020/2021 academic year.
	2019/2020 and 2020/2021	0.05	0.000	Reject H_0 .	There is a difference in the median final grades of the FE in the 2019/2020 and 2020/2021 academic year.

The IPA aspects and CSI results, based on the questionnaire and equation (7), are presented in Table 3.

Table 3. CSI from Learning Media during the Covid-19 pandemic

No	Aspects to be measured	Performance	Importance	CSI
1.	Lecture material is well delivered through video.	4.07	4.24	95.95%
2.	The Visual display of video.	4.15	4.19	99.12%
3.	The clarity of video audio.	4.12	4.26	96.69%
4.	The background in the video is related to the spirit of paying attention to the material.	3.94	3.93	100.31%

No	Aspects to be measured	Performance	Importance	CSI
5.	The clarity of examples solution in the video.	4.18	4.23	98.84%
6.	Understanding of the material in the video.	4.06	4.18	96.92%

Furthermore, the sample of the learning video can be accessed on the page: [http://bit.ly/sample video calc](http://bit.ly/sample_video_calc).

The statistical summary in Table 4 provides information that there are differences in the FE mean and median scores in the three academic years.

Table 4. Summary of descriptive statistics of research Data

Data source	Academic Years	Average	Median	Minimum	Maximum
Result of final exam	2018/2019	74.9	79	22	100
	2019/2020	59.8	61	0	100
	2020/2021	77.7	86.67	0	100

Table 4 shows that the highest average and median scores on FE are in the 2020/2021 academic year. This indicates that the online learning method implemented in the 2020/2021 academic year has positive impacts toward students FE scores. The difference is confirmed statistically significant by the Kruskal Wallis statistical test, and it is reinforced by the Mann-Whitney statistical test. Both statistical tests confirmed that the online learning outperformed the offline learning and provide the highest FE median score.

The results from questionnaire at Table 3 show that the average CSI value is 97.97%. It means that the video as a learning media to support the online learning has been very satisfying. The IPA scores visually can be seen in Figure 1.

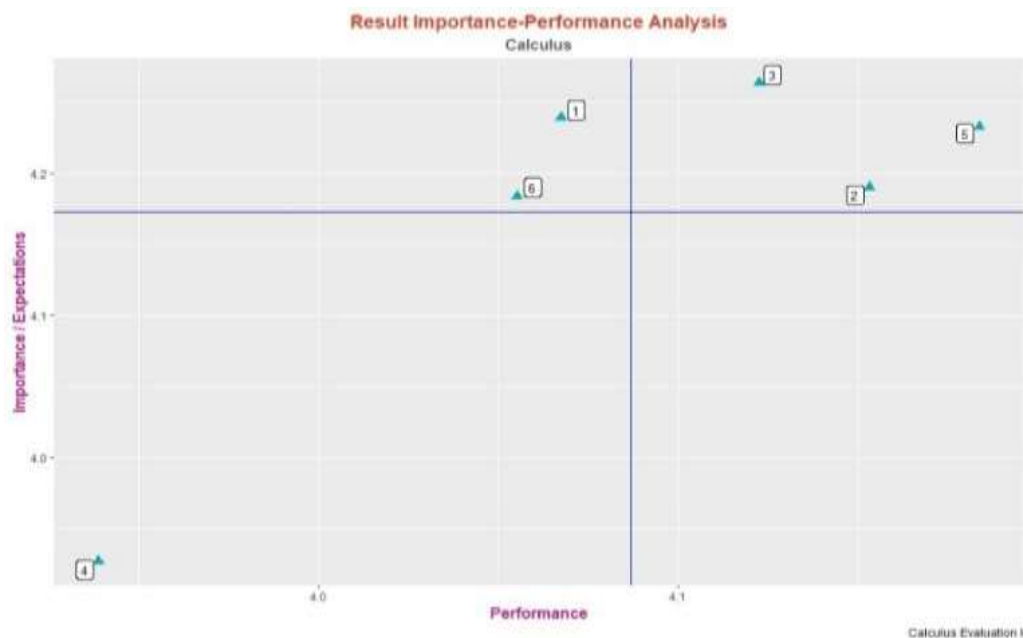


Figure 1. Result of Importance-Performance Analysis

Figure 1 reveals that the components fall into quadrant I are visual display of the video (2), the clarity of the sound/audio (3), and the clarity of examples solutions in the video (5). These mean that most students think that the learning media in the form of videos has good performance and is considered essential for students. A good display is expected to make the students feel relax such that it makes students more interested in the first place. As they can continue to follow the material in the video step by step. Good sound/audio is necessary in order to make students not quickly bored to learn the material. It is assumed that the right audio can increase students' concentration and liven up the atmosphere. This is reinforced by research of Roffiq *et al.* (2017) which concluded that several types of music can affect the learning atmosphere.

The last component, which is about the clarity of example solution, is a significant aspect for theoretical part. The availability of examples makes the step by step on how to solve the problem related to material, easy to be followed and understood. Even Though there is no lecturer around. The components that lie in quadrant II, indicating that they are the main priority, are related to lecture material delivery and understanding the material in the video (6). It is concluded that those two components need to be prioritized in the improvement. This can be done for example by well preparing the scenario for the video, such that the videos are more coherent, neat, and easier for students to understand. In quadrant III, which is about low priority, the component is about the background in the video related to the spirit of paying attention to the material (4). The questionnaire shows that the audio/back sound in the video is needed but it should not be too loud or even exceed the lecturer's voice. The questionnaire also reveals that 61.35% of students are happier with the duration of the video within 5-10 minutes and do not like it if the duration was more than 25 minutes. About 80.37% students preferred the delivery method in cheerful mode, which is video should be colorfull, backsound available and the lecturer is present as well. The students' impression about the online learning is visualized on a word cloud which can be seen in Figure 2.

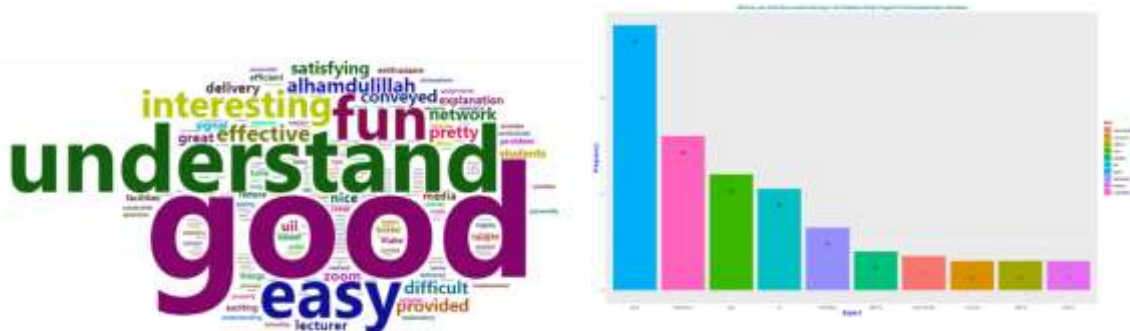


Figure 2. Word Cloud Advantages Of Online Learning

Figure 2 shows that most students have good impression toward the online learning process and understand the material of Calculus 1. By online learning where the video is provided, they can learn the material many times before the lecture. The advantage of learning through video can be seen in the the word cloud presented in Figure 3.

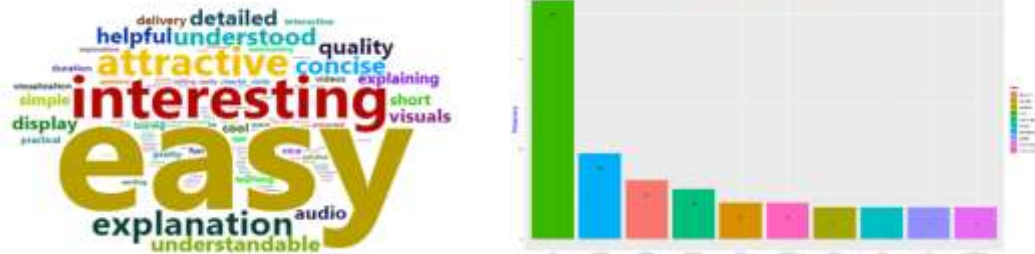


Figure 3. Word Cloud Advantages Of Learning Videos

The learning video make students feel easy to understand the material, feel enthusiasm and excited to watch the video. Students suggest that some aspects need to be improved such as the material should be covered all course outcomes (currently, it is only for some course outcome only), the explanation should be in more detailed, and the lecturer audio should be more clear than the backsound audio. These can be seen in Figure 4.

All this results, pointed out that the concerns that the pandemic will affect students interest in learning Calculus I, students ability to understand the content of Calculus I and also the final results of Calculus I, are unnecessary.

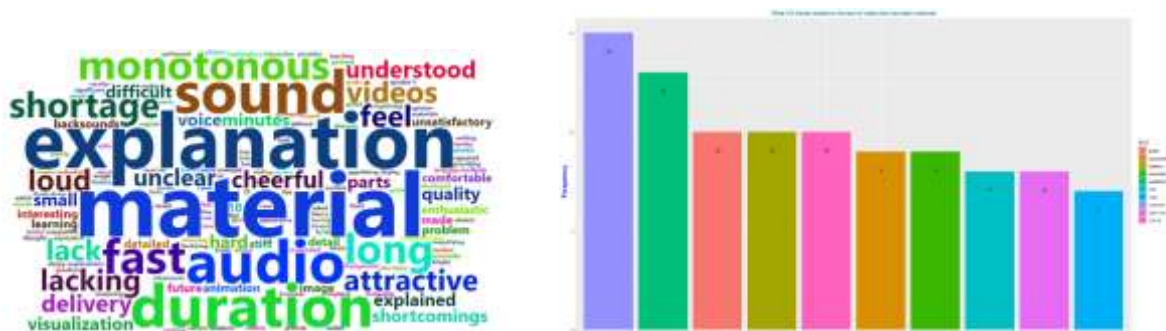


Figure 4. Word Cloud Lacks Learning Videos.

Conclusion

Based on our research, we confidently can conclude that although the learning was carried out during the pandemic, good results were obtained when compared to the two previous academic years (before the pandemic). This is supported by the Kruskal-Wallis and Mann-Whitney statistical tests. The average CSI value is

97.97%. This shows that the performance of video learning media in supporting the online learning meet its expectation. The CSI also suggests that 50% are in quadrant I (achievement priority), 33.33% are in quadrant II (high priority), and 17.67% are in quadrant III (low priority). The results of text mining related to learning media show that the videos provided are easy to understand, engaging, and straightforward in the explanation. The CSI, IPA, and text mining also reveals that there are some aspects for the improvement. Some aspects which need improvements are the material (should be add for more topics), audio, and video duration.

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