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AN EVALUATION ON ONLINE LEARNING BY DATA VISUALIZATION: A CASE STUDY FROM INFORMATION TECHNOLOGY EDUCATION PROGRAM

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Abstract

The result of the learning process can be seen using scores from the exam to evaluate the learning quality. This study focused on comparing the learning outcomes in Universitas Muhammadiyah Tasikmalaya (UMTAS) students, especially in one class in the Information Technology Education Program, between face-to-face learning and online learning. The learning process is observed in order to gain some insight into the difference in academic performance and student's perception between face-to-face and online learning. The comparative results of this research will be described through data visualization using R programming language. Data visualization using R programming language will result in numbers, summary data, and graphics. The results of this study showed that the exam scores and student's perceptions after face-to-face learning are higher than the online learning. This study shows around 93% of students from the Information Technology Education Department demanded more face-to-face classes than online learning.

INTRODUCTION

Education is very important for humans and will have an impact on the development of a country's progress. Education must be carried out in any condition as a form of consistency in the efforts of the nation to educate its people. The importance of education in society also serves to prepare young people to become adults so that they can produce the next qualified leader. It cannot be denied that one of the important tasks of education is to enable people to understand their own capabilities. Students must be equipped with the knowledge and skills needed to actively count among members of society and support the development of shared values and common identities within a nation. Education is a process that increases a person's ability to own wisdom and choose the best alternative solution in whatever situation they face. It means personal development to prepare it for the best approach to a problem at any given time. Education is defined as 'the ability to adapt to changing situations and the environment' (Idris et al., 2012).

The COVID-19 outbreak has caused disruptions in education and raised issues with global health that have been exceedingly challenging for international health institutions to handle. No country or race in the globe is currently immune to the coronavirus

pandemic, and COVID-19's rapid expansion and catastrophic effects seem to be overwhelming the whole planet. The coronavirus pandemic knows no bounds and has a swift and significant impact. Just a few months after the disease's emergence, it has significantly altered everyone's way of life, forcing billions of people to "stay at home," "observe self-isolation," and work and learn from home (Michael Onyema et al., 2020).

Based on the situation and conditions related to the pandemic emergency response in Indonesia, many universities are holding online teaching activities starting in early 2020. This emergency condition is in accordance with the announcement from the government of the Minister of Education and Culture in Circular Letter Number 4 of 2020 concerning the Implementation of Education in an Emergency for Coronavirus Disease. (Covid-19) (Mendikbud Terbitkan SE Tentang Pelaksanaan Pendidikan Dalam Masa Darurat Covid-19, 2020) (Rubiani et al., 2021). This emergency condition has made everyone have to be ready to digitalize the learning content with existing media and any kind of facilities.

Before this circular letter was issued, lecturers at the University of Muhammadiyah Tasikmalaya (UMTAS), especially the Information Technology Education Study Program at Teaching and Learning Faculty, still used the lecture method for learning conducted by face-to-face in class (Fitri et al., 2023). After this special condition, learning began to be implemented in mid-March 2020. Therefore, the success of the education method being conducted needs to be evaluated, even when another method of teaching is changed suddenly.

Distance learning that has been carried out using this online network uses several LMS (Learning Management System) facilities for e-learning, such as Google Classroom and Edlink, video conferences through Zoom, and Google Meet (Fitri & Rubiani, 2023). Even using chat media like WhatsApp. Electronic technology learning has grown significantly as a medium of learning for education that has developed and advanced over the years (Abou El-Seoud et al., 2014). Based on existing research on technology for learning, it is found that there have been more efforts in advancing technology to understand the needs and learning styles of students through instructional design for digital content (Abou El-Seoud et al., 2014).

Research from Setiawan et al. (2021) found that educators tended to choose Moodle over competing platforms, including Edmodo, Classdojo, Schoology, Brightspace, Google Classroom, and Microsoft Teams. The second time around, the data demonstrates the opposite, with the Google Classroom type outperforming the others following the COVID-19 pandemic. It is because using both platforms is efficient, quick, and satisfying (Setiawan et al., 2021). Apart from using the Learning Management System (LMS), which is popular among educators, sometimes the educators also use web-based or android-based applications to be able to share knowledge so that learning and teaching activities keep running according to the curriculum (Fitri et al., 2023; Nita Yunitasari et al., 2022; Ramdani et al., 2022). It is also undeniable that in the use of streaming media for online viewing, such as Zoom, many conduct training to improve the teaching performance of educators (Fitri & Rubiani, 2023).

In fact, another study found that many previous research identified the satisfaction of face-to-face learning as higher than online learning. The research also argued that face-to-face learning is more amenable compared to online learning in terms of social presence, social interaction, and satisfaction. However, the findings of this study argued that there is no significant perception of online learning and face-to-face learning among four different levels in the university (freshman, sophomore, junior, and senior) (Bali & Liu, 2018).

The results show a bi-directional relationship between technology use and academic performance; overall, there is a negative but minor significance relationship between technology use and academic performance, but there are significant positive correlations

between some particular types of technology, such as social media use (Rashid & Asghar, 2016).

Another study's results showed that the majority of the participants were adversely impacted by the pandemic era and experienced unpleasant feelings of worry, despondency, and boredom. The pandemic educational process had more drawbacks than strengths, including a lack of interaction and communication that caused students to isolate themselves, issues with exams, traditional educational practices, a heavy workload, and time management issues (Tümen Akyıldız, 2020).

When compared to on-campus programs, online programs often experience higher levels of withdrawal because distance learners are more prone to feel alone and demotivated. To help online students track their academic progress alongside that of their peers, as a motivational tool within a diverse group of learners, and to lessen feelings of isolation by reassuring distance learners that they are part of a larger online community, tutors may think about communicating progress data as dashboards (Smith, 2019). A study by Karnalim et al. (2021) demonstrated that during a pandemic, students only struggle with difficult assignments that call for supervision. It identified four arguments in favor of offline instruction in the pandemic situation. It provided increased oversight and student involvement. Additionally, it encourages kids to ask questions. Additionally, that style of instruction is well-known to many students (Karnalim et al., 2021).

The Study by Ram Gopal et al. (2021) showed that the students' expectations are the second most important element influencing their satisfaction with online education. During the lessons, students could have some expectations. It is anticipated that students will perform better on exams if the instructor is aware of this expectation and tailors the course material to meet the needs of the learners (Gopal et al., 2021). an improvement in students' academic performance and lend credence to the notion that organizational factors may play a role in the implementation of emergency remote teaching. However, the analysis did not uncover any differences between courses with various class sizes or delivery methods (Iglesias-Pradas et al., 2021).

The year 2001 was chosen as the starting point for the time-trend analysis by Aras Bozkurt (2022), who used it in the study since the year that saw a significant increase in the usage of internet technologies across all spheres of life, including education. It was notable that these elements closely align with the online learning dimension of blended learning, given that this approach combines onsite and online learning (Bozkurt, 2022).

The purpose of this study was to find a description of student learning outcomes using face-to-face learning methods in class and online learning. Based on the different results obtained, the reasons for the learning outcomes obtained from students' perceptions of face-to-face learning and online learning will be examined. Descriptions of the findings and perceptions of students who undergo the existing learning process will be visualized using the R programming language. The learning outcomes will provide insight to the community about the quality of the learning methods that have been carried out so that they contribute to the development of technology or methods in learning and training.

Data visualization is a crucial tool for data exploration that enables the discovery of interesting patterns and data structures. Additionally, it is crucial to use visualization when disseminating information to a large audience (Gatto et al., 2015). One of the tools that can be used to visualize data is R programming.

R is a programming language and environment for statistical and graphic computing. This is a GNU project similar to the S language and environment developed at Bell Laboratories (formerly AT&T, now Lucent Technologies) by John Chambers and colleagues (Foundation, n.d.). R programming language works on free statistical software (Fox & Leanage, 2016). Based on the many journal articles on statistical

software, R is one of the most popular programming languages and also has a simple way to create graph data descriptions.

METHOD

The method used in this study was a survey, and the data was analyzed using a descriptive quantitative approach. The participants in this study are UMTAS (Universitas Muhammadiyah Tasikmalaya) students, especially students in the Information Technology Education Department who take mathematics courses, where the variable measured is exam scores of contribution to learning outcomes, such as academic performance. The Material Tested section is about the logic section, which is the base knowledge the student must have to learn more about information technology. The exam was conducted face-to-face after the teaching activity as usual in the real classroom before the official letter was announced to society and after distance learning was conducted online, including using Zoom or Google meeting. The exam in distance learning conditions was conducted by using "edlink quiz" feature. Those result exam scores were collected as the data comparison for this study.

Edlink, one of PT Sevima's top products and services, was created to assist instructors and students with online learning activities. Users have access to a number of tools, including online tests, the ability to upload and download educational materials, video conferencing to support distance learning, and free-roaming classes to support government initiatives. The online message option in the Edlink application is one of the features that facilitates students' ability to communicate directly with professors. More than 7,000 professors from 270 colleges and more than 150,000 students have utilized Edlink as an LMS (Learning Management System) (Fatihahsari & Darujati, 2021).

In this study, the population was taken from all students in the Information Technology Education Department. Based on respondents who returned the questionnaire, only 40 respondents from the online questionnaire were distributed, so the study sample consisted of only 40 students.

The data collection method is by distributing a questionnaire used to obtain the information, such as the score record after conducting the exam or test, and by filling out a perception questionnaire, which is also conducted by each student. A method for collecting primary data using a set of questionnaires about student perception measured through careful planning arranged and packaged in such a way that the answers to all questions can really describe the actual learning experience from the student's point of view. Collecting the data from the perception survey used 10-item questions with a Likert scale of one to four points of scale, and brief reasons from the participants described their point of view.

Some benefits of using R Programming language (Culpepper & Aguinis, 2011) are R is an open-source package, but it is commercially available, creating publishable graphics, and also R is especially well suited for educational uses because it is cost-free. Installing R in computer laboratories and utilizing it in basic and advanced statistics and measurement courses can help universities save money. R's need for students to learn the R programming language is undoubtedly a drawback. Using object classes that can easily interpret one another, R's flexibility allows for the import, exploration, processing, and analysis of spectral color data using a wide range of user-defined models (Maia et al., 2013).

Data were analyzed through descriptive statistics, which was constructed by R Studio using R language programming to show the data visualization and graphics as the results described in this study. Data analysis and statistical modeling both require graphic visualization. For displaying and evaluating data, two-dimensional plots like scatterplots, histograms, and kernel smoothers are often used (Adler et al., 2003).

The findings of this study will show the comparison numbers so that it is easy to understand and reach a conclusion. The students who enjoy the course of study are not known to have opinions on the benefits and drawbacks of e-learning versus face-to-face instruction. To maintain the sustainability of the educational act, it is important and helpful to analyze how they view these changes during the outbreak of the pandemic (Gherheș et al., 2021).

RESULT

This study presents the findings and outcomes of the descriptive statistics result of online learning compared with FTF (Face-to-face) method in Math courses by evaluating the students' achievement based on exam scores and grades. One sample group of students was allocated for the research for learning, and the same group was also for FTF method. As mentioned in the previous section, 40 students participated in this study.

After implementing the mentioned methodology for all participants, a testing exam was conducted for all students in the class to evaluate the student's achievement scores. The score was collected and exported into a table. The other learning method also had the same implementation for online learning and doing online exams using edlink (Edlink , 2017) as a Learning Management System (LMS) or platform, which was provided by the campus in Universitas Muhammadiyah Tasikmalaya.

After all necessary data were collected, the data was processed using R studio. To process the data, we have to create code for the program in R language. Previously, we had to prepare a package that provides the keywords for the units in data processing needed, such as `dplyr, ggplot2, tidyverse`. The way to write how to import the packages in the library can be seen in how the program code is written at the beginning of each code block program, which is available in this script.

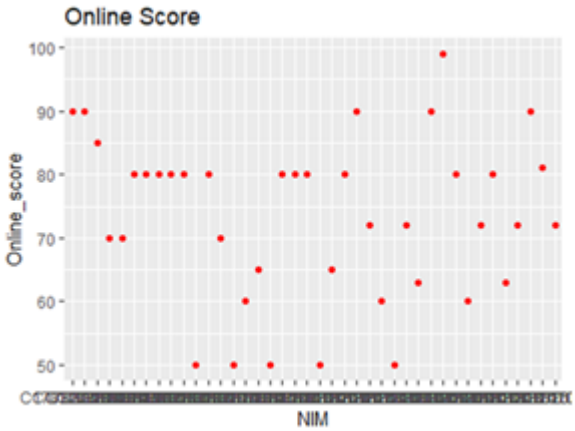

Figure 1. Exam Score after Face-To-Face

1.1 Program codes to create data visualization in Scatter plots or Dot Plot

```
library(dplyr)
library(ggplot2)
Data_Grade=read.csv('Nilai.csv')

ggplot(data_nilai, aes(x=NIM, y=FTF_score))+
     geom_point(colour='blue')+
     labs(title='Face-to-Face score')
ggplot(data_nilai, aes(x=NIM, y=Online_score))+
     geom_point(colour='Red')+
```

```
labs(title='Online score')
```

Before processing the data into analysis, the data is read by reading a file function that has been converted into (*.csv) form. Order Point command on the scatter plot diagram by the `ggplot()` and `geom_point()` commands. The compilation results after running the code block program in this section are shown in Figures 1 and 2.

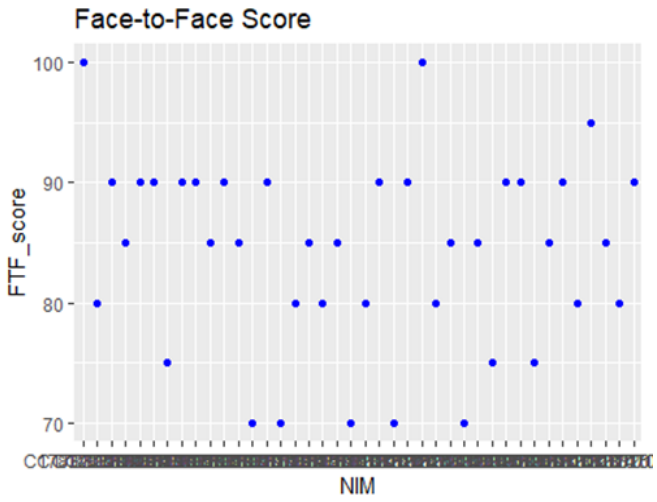

Figure 2. Exam Score after Face-To-Face

In Figures 1 and 2, the score distribution data from the exam results of the participants are used as evaluation material for this evaluation. On the X axis, you can see the text of NIM, which stands for Student ID, which was collected previously as the main identity in the data. For the Y Axis, each student obtained a score. After getting an overview of the data from the scatter plot, we can see a summary of the data using the R Language by typing the command > summary (file_name), which in parentheses is the file name import as the dataset.

The tidyverse (Wickham et al., 2019) includes data import, cleaning, manipulation, visualization, and programming operations that form the core of every data science project are all included in. Practically every project will employ a number of domain-specific packages from sources outside the `tidyverse`. Notably, the tidyverse lacks communication or statistical modeling capabilities.

Ggplot2 is the tidyverse method for performing necessary graphing. This replaces and improves the standard R methods for data charting (Campbell, 2019). The dplyr package helps R users rapidly store and access massive volumes of data while manipulating, sorting, summarizing, and merging data frames (Broatch et al., 2019).

In Table 1, the results of the data summary from the participants describe the most scores based on aggregate functions such as minimum, 1st Quartile, Median, Man, 3rd Quartile, and Maximum score. The summary of comparisons from Table 1 shows that the mean score of participants with the FTF Method is better than the Online method because 84.12 is higher than 73.28.

Table 1. Summary Data of Participants' Score

Description	Face-to-Face	Online
Min.	70.00	50.00
1st Qu.	80.00	64.50
Median	85.00	76.00
Mean	84.12	73.28
3rd Qu.	90.00	80.00
Max.	100	99.00

1.2. Program Codes to Create a Bar Chart

```
library(dplyr)
library(ggplot2)
Data_abc=read.csv('Nilai.csv')

ggplot(Data_abc, aes(x=Grade, y=N, fill=status))+
geom_bar(stat="identity", position=position_dodge())+
geom_text(aes(label=Precentage)
position=position_dodge(width=0.5),+
      vjust=-0.10))
      labs(title='Comparison Face-to-Face and Online
Learning')
```

The command in R Language for creating a bar chart is described by the function of `ggplot()`. Meanwhile, a side-by-side arrangement for FTF and online group types was created using the function `geom_bar()` arranged and the way the bars in the chart are in the function `position_dodge()`. Function labs('title') were used to create the title of the chart. The results of the program code to create a bar chart are shown in Figure 3.

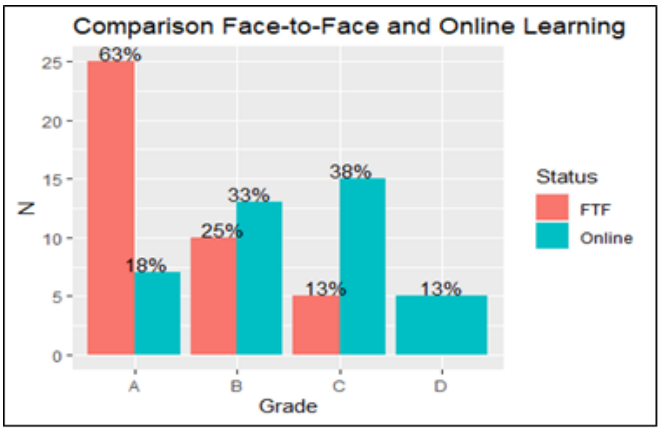

Figure 3. Exam Score after Face-To-Face

Figure 3 compares the data between types of learning through Face-to-Face and Online. In the FTF type, there are only three kinds of grades, namely A, B, and C, while in the type of online learning, there are four types of grades, namely A, B, C, and D. Grade A is when the score ranges from 85-100, class B is the range scores 75-84, C

values 55-74, and D 40-54. The score obtained by FTF is better than that obtained online, which shows the numbers at around 63% and 18%, respectively.

1.3. Program Codes for creating Pie Chart of Face to Face Learning data

```
library(dplyr)
library(ggplot2)
Data_abc=read.csv('Nilai_ftf.csv')
Data_nilaiftf_persen=mutate(Nilai_ftf,
Percen=(N/40)*100)

Nilaiftf=Data_nilaiftf_persen$Percen
Ftfgrade=Data_nialiftf_persen$Grade

lbls=paste(ftfgrade)
lbls=paste(ftfgrade,Nilaiftf)
lbls=paste(lbls,"%", sep="")

pie(Nilaiftf, labels=lbls,col=rainbow(length(lbls)),
    main="student's Grade for FTF Learning")
```

Special commands for making pie charts are contained in the syntax function `pie()`. In the value label assigned from the content's column in the existing table, use a new variable called lbls and call percent the column, which contains the percentage number of the data description. To color the existing pie chart, you can fill in the attribute of the items named `col=rainbow()`. In the command to color the diagram, the color will be filled randomly as much as the portion of the total pie. Meanwhile, the attribute main inside the `pie()` function will assigned the title description. Function `mutate()` will create a new variable, including a mathematical calculation.

3.4. Program Codes for creating Pie Chart of Online Learning data

```
library(dplyr)
library(ggplot2)
Nilai_online=read.csv('Nilai_online.csv')
Data_ol_persen=mutate(Nilai_online, Percen=(N/40)*100)

Nilai_ol=Data_ol_persen$Percen
Ftfgrade=Data_ol_persen$Grade

lbls=paste(olgrade)
lbls=paste(olgrade,Nilaiol)
lbls=paste(lbls,"%", sep="")

pie(Nilaiol, labels=lbls,col=rainbow(length(lbls)),
    main="student's Grade for Online Learning")
```

In the code block program for the circle pie diagram, there are two figures (4 and 5) making for parts of the percentage acquisition between FTF and Online types of

learning. The results of the compilation syntax program for pie charts can be seen in Figures 5 and 6. In the two pie charts in the image below, it can be seen that FTF learning has three upper classes while Online learning has one additional low grade, namely grade D. By the percentage value figures, the acquisition of A value from FTF learning decreased by 45% after doing Online learning.

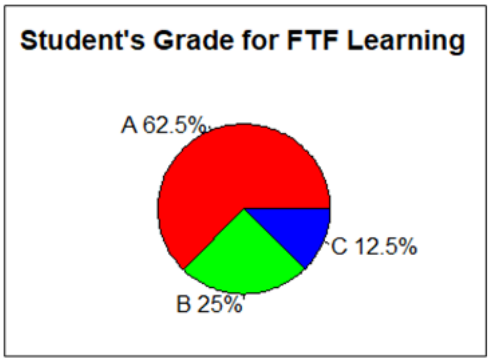

Figure. 4 The numbers of Grade obtained by FTF (Face to Face)

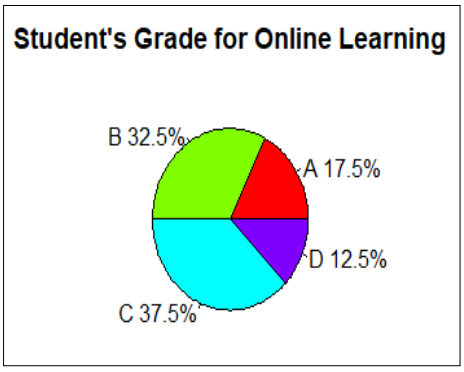

Figure. 5 The nu
Online

DISCUSSION

Data visualization is crucial for simplifying complex data, aiding understanding, supporting decision-making, facilitating effective communication, and uncovering meaningful insights. It enables individuals to go beyond the numbers and discover patterns, trends, and relationships, leading to improved comprehension, data-driven decisions, and effective communication of findings.

The graphical perception of various visual design choices commonly encountered in information visualization, such as different types of charts, color palettes, and visual encodings (Heer & Bostock, 2010). Visualizations generally have a positive impact on judgment and decision-making. They enhance accuracy by improving information processing, aiding in pattern recognition, and facilitating the integration of complex data (Eberhard, 2023).

Data visualization is an effective means of presenting complex data to a wider audience, including stakeholders, executives, and non-technical users. By presenting information in a visually appealing and intuitive manner, data visualizations can effectively communicate complex concepts, findings, and trends to diverse audiences, irrespective of their level of data literacy. Visualizations can simplify complex topics and facilitate knowledge transfer and understanding. Humans are highly visual beings, and we often process visual information more effectively than raw data or text. Data visualization transforms complex and abstract data into visual representations that are easier to understand, grasp, and remember. It allows viewers to quickly absorb the information and identify patterns, outliers, and trends that might not be apparent in raw data (Xiao et al., 2021).

By bringing data to life, visualizations have the ability to create a fascinating tale. Facts visualizations may produce a compelling and captivating narrative that enthralls the audience by fusing facts with stories. They enable speakers to effectively deliver the

message, highlight important details, and forge an emotional connection with the content, improving impact and memory (Hudiburgh & Garbinsky, 2020). Data exploration can also be aided by data visualization. Users can alter variables, filter data, and drill down into specifics by engaging with visualizations, enabling them to examine the data from various perspectives and pose new queries. Users are encouraged to actively interact with the data and find unexpected insights because of the interactive nature of data visualizations (Panse et al., 2022). From the results shown before, many numbers were stated to be higher in the face-to-face learning group. Based on the score data summary shown in Table 1, the majority numbers are higher in the group of FTF learners than in Online Learning.

From the data collected from the questionnaire, student PTI UMTAS chose face-to-face learning over online learning. It shows from figure 6 that the opinion value in percentage is way different about (85%) difference. About (7.5%) of students who chose Online learning explained that the cost spent for daily transport to campus is reduced. Another student also explained that online shopping makes them safer because the pandemic condition is still worrying. However, the cost of tuition is also reduced and can be transferrable for internet funding.

Another research study found that there is a significant advantage of cost reduction by doing online learning, while face-to-face learning has been shown to have a negative impact on student learning and dilute the learning process (Bir, 2019). Bali and Liu (2018) found a satisfaction-rated Mean of about 44.07, with a Standard Deviation of 7.48, which supported the hypothesis that face-to-face learning led to more positive perceptions, higher levels, and stronger sense compared to online learning. The main reason why face-to-face learning is higher than online learning is due to the lack of social presence and social interaction toward online learning (Bali & Liu, 2018).

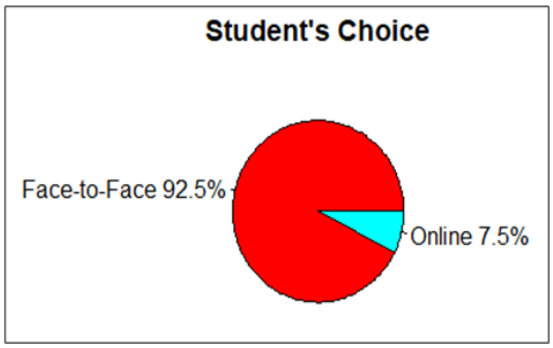

Figure. 6 Student's Choice between FTF and Online

The study by Meera Mathera and Alena Sarkans (2018) found that participants in the class reported that group projects, attending lectures, participating in discussions and debates in class, and completing assignments were their primary forms of contact. Compared to those who took the course in person, the burden for online students seemed more reasonable. The majority of online and in-person participants (70%) assessed their performance as excellent and good when asked to evaluate their performance in the course. 58% of the participants in the two modalities indicated that group work was their biggest obstacle during the course. Additionally, online students identified communication opacity, late faculty feedback, and technical difficulties as barriers to their learning (Mather & Sarkans, 2018).

The study findings (Keržič et al., 2021) show that the administrative, technical, and learning support provided by tutors and the library, teachers' active participation in the

process of online education through their responsiveness and timely feedback, and overall system quality with the mode of delivery and IT infrastructure were the main contributors to the quality of e-learning during the first wave of the COVID-19 pandemic. Digital proficiency and online interactions between students and teachers were found to be statistically significant but slightly less relevant determinants.

In a South African university, another study discovered that students' performance was favorably correlated with good wifi access compared to using mobile internet data. Additionally, the worse academic performance in students who showed difficulty adjusting to online learning and a preference for independent study over aided study (attending live lectures or watching recorded lectures) by reading through class notes and slides. According to the research, it may be important to enhance digital infrastructure and lower internet connection costs in order to lessen the effect of the COVID-19 pandemic on educational outcomes (Chisadza et al., 2021).

In ten studies (Jones et al., 2022), participant interaction was found to be higher in face-to-face groups; three of the studies claimed that online groups produced stronger contact, while the other six reported equal engagement. None of the studies provided comprehensive comparisons of resource utilization. This analysis shows that there is still some disagreement on whether face-to-face or online focus groups are more advantageous in terms of the data generated and the resources needed.

After the study literature was examined, it also connects to this study that the students in Tasikmalaya, especially in UMTAS, still demand face-to-face learning in class so that they can feel the reality of the learning process. However, some of the students in the information technology education program do not have the same ability level to understand the subject material when they are only studying in private using technology. The students admit they still need real social interaction.

CONCLUSION

The visualization using R language needs more ability to understand the programming syntax code. Before processing the data, we need to prepare it in a good form that is easy to analyze. Creating the chart needs more understanding of the ggplot() function to make it better for presenting the data.

Based on the conditions nowadays, Universities must provide online learning classes to maintain the education process in the academic field. More effort should be focused on creating e-learning content to make the quality similar to or even better than Face-to-Face Learning. In Universitas Muhammadiyah Tasikmalaya, especially the students in the Information Technology Education Department they got the majority higher scores from exams by face-to-face learning in class than by online learning. The scores showed that the academic performance of students is better during face-to-face learning because some of their reasons explained that learning in class makes them feel the real interaction between student and teacher, as well as among students who can fulfill basic social human needs.

Yet the perception from students explains their choice of FTF is better than Online learning in the case of motivation, spirit, responsibility, and even humanity ability. Therefore, a survey instrument was distributed through the online form to students to explore student’s perceptions toward online and face-to-face courses.

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