

The Effectiveness of Online Learning Based on Learning Outcomes in the Mathematics Course during the Covid-19 Pandemic Period

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Abstract

The implementation of online learning due to the COVID-19 pandemic by the Indonesian government through the Ministry of Education has led to changes in the condition of the lecture system in public and private universities. This study aimed to determine the effectiveness of online learning in the mathematics course at STIKes IKIFA in the Pharmacy Study Program during the 2020/2021 academic year using a quantitative descriptive method. Student learning outcomes from pretest and posttest were compared to find the differences before and after treatment during online learning. A total of 95 students were recruited as sample through total sampling. The measurement of the effectiveness of online learning based on students' outcomes showed that 92.7% of students scored higher than 70 for posttest. The online learning would be considered effective if the students' learning outcomes exceeded 80%. The effectiveness could also be seen in the increases in learning outcomes recorded by 85.26% of the students. It can be concluded that the online learning implemented in STIKes IKIFA was in the effective category. This result was made possible by a sound collaboration between the university and the lecturer as facilitator in creating an environment for online learning during the COVID-19 pandemic.

Keywords: Effectiveness, Online Learning, COVID-19 Pandemic, Gain Score Test, Learning Outcomes

Abstrak

Pemberlakuan pembelajaran daring (*online*) akibat pandemi *COVID-19* oleh pemerintah Indonesia melalui Kementerian Pendidikan dan Kebudayaan telah menyebabkan perubahan kondisi sistem perkuliahan di semua perguruan tinggi negeri maupun swasta. Penelitian ini bertujuan untuk mengetahui efektivitas perkuliahan daring pada mata kuliah matematika di Program Studi D-III Farmasi STIKes IKIFA pada tahun ajaran 2020/2021 dengan menggunakan metode deskriptif kuantitatif. Data yang digunakan adalah data hasil belajar mahasiswa pada *pretest* dan *posttest* yang kemudian dibandingkan untuk mencari perbedaan sebelum dan sesudah diberikan perlakuan berupa perkuliahan daring. Mahasiswa aktif sebanyak 95 orang digunakan sebagai sampel penelitian yang dipilih menggunakan teknik *total sampling*. Hasil yang diperoleh menunjukkan efektivitas pembelajaran daring diukur menggunakan ketuntasan belajar mahasiswa, yaitu nilai mahasiswa yang lebih dari 70 sebanyak 92,7% untuk *posttest*. Pencapaian hasil belajar individual di atas nilai standar yang melebihi 80% dapat dikatakan bahwa pembelajaran daring sudah efektif. Efektivitas juga dilihat pada 85,26% mahasiswa yang mengalami peningkatan hasil belajar. Sehingga, dapat disimpulkan bahwa secara keseluruhan efektivitas pembelajaran daring di STIKes IKIFA sudah efektif. Hal ini dikarenakan kolaborasi yang cukup baik antara pihak perguruan tinggi dan dosen sebagai fasilitator untuk menciptakan lingkungan belajar yang kondusif di tengah pandemi *COVID-19*.

Kata kunci: Efektivitas, Pembelajaran Daring, Pandemi *COVID-19*, Uji *Gain Score*, Hasil Belajar

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INTRODUCTION

The coronavirus disease 2019 (COVID-19), first discovered in Wuhan, China, is a communicable disease caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARSCoV-2). SARS-CoV-2 is

a new type of coronavirus never before identified by humans (Kemenkes, 2020). As of March 2021, this virus has spread to virtually all countries and has infected 12,536,880 people, leading to a death toll of 2,703,780 (WHO, 2021). The impacts of the disease have proliferated in various life aspects of the global society. One of the sector impacted by the COVID-19 spread is education. This disease has forced a move of the learning process from face-to-face instructions at school or university to study from home (Sarwa, 2021). The learning activity from home is regulated under Circular Letter of the Indonesian Minister of Education and Culture No. 3 of 2020, 9th of March, 2020, on COVID-19 Prevention at Education Units (Kemenristekdikti, 2020), Circular Letter of the Acting Director General of Higher Education No. 302/E.E2/KR/2020, 31st of March, 2020, on the Learning Period for the Implementation of Education Programs (Dirjendikti, 2020), and several instructions issued by each local government. As many as 646.2 education units were affected by COVID-19, forcing 68.8 million students to study from home and 4.2 million teachers and lecturers to teach from home (Muhammad, 2020).

The spread of COVID-19 has made it inevitable to conduct learning distantly with the aid of the Internet, which is also known as e-learning or online learning. Two approaches may be employed by lecturers in conducting online learning, namely, synchronous and asynchronous approaches (PJJ UI, 2020). The synchronous approach is meant to denote to the simultaneous class interaction between the lecturer and students via a video conference technology, while the asynchronous approach is meant to denote a non-simultaneous class interaction through a discussion forum or student assignment (Ma'soem, 2021). Online learning based on the first approach can be implemented virtually using the applications Google Meet, Zoom, WebEx, and Microsoft Teams, to name a few. Meanwhile, technology use in the second approach is exemplified by the use of Learning Management Systems (LMSs) such as WhatsApp and websites (Muhammad, 2020).

This sudden change of class learning model has caused a lack of preparedness on the parts of both the students and the lecturers in adapting. A wide range of problems pertaining to ineffective online learning has emerged due to inadequate availability of facilities such as gadgets, economic restrictions hindering individuals from affording Internet quotas, students' lack of learning motivation, and lecturers' inability to perform objective assessments (Sarwa, 2021). An online learning process does not allow an in-person interaction during the knowledge transfer process between the lecturer and students, demotivating the students and making it difficult for them to understand the materials delivered (Limbong & Simarmata, 2020; Syarifuddin *et al.*, 2021), hence students' affected academic achievements (Haryudi, 2021). It is for this reason that online learning processes do not always produce satisfactory outcomes (Darma *et al.*, 2020). A study by a Yogyakarta-based private university revealed that only 26% of students gained a proper understanding out of the learning process, while the remaining 74% did not. The mean mid-term test (UTS) scores for the courses Introduction to Real Analysis, Plane Analytic Geometry, and Integral Calculus were 52, 57, and 61, respectively (Kusumaningrum & Wijayanto, 2020).

Early in the pandemic period, STIKes IKIFA conducted online learning with an exclusive use of an LMS, in which case the LMS was used to deliver materials and assign tasks to students, to submit works (for the students), and to provide a forum for a discussion. Some of the students complained of their learning difficulties if the learning implementation only relied on materials delivery and tasks assignment. A research work in South Tapanuli in 2020 showed that the significance of the effectiveness of online learning during the pandemic was acceptable. However, online learning's effectiveness was limited only to assignment of tasks; to help students understand the materials, online learning was still considered ineffective (Hennilawati & Hartini, 2020). However, research showed that online learning not always produce unsatisfactory outcomes (Darmalaksana *et al.*, 2020). Online learning is considered effective if appropriate methods and approaches are used and if all members of academic community work hand-in-hand. These difficulties that students experienced in understanding materials have led to the need for conducting learning in a manner alike to classroom face-to-face learning. A survey on students of Mathematics Tadris of IAIN Takengon, Aceh, and students of the Educational Technology Study Program of Universitas Baturaja revealed that 90% of students preferred face-to-face class to online learning where the conditions allowed (Mandasari *et al.*, 2020; Ningsih, 2020).

Online learning has been ongoing for over one year since its inception in March, 2020, and all members of academic community have been well-adapted to it. STIKes IKIFA has added an online learning application named Zoom with which lecturers and students may conduct learning in a similar condition as that when they did face-to-face in the classroom. For mathematics learning that requires detailed explanations regarding calculations, the Annotate menu in the Zoom application can be used. Using Zoom, lecturers may explain calculations, mark images or texts, and create drawings or illustrations to help students understand the materials explained. A research study on the learning implementation in the Mathematical Statistics course at Universitas Bengkulu using WhatsApp Group (WAG) indicated a fairly effective result if seen from the students' learning outcomes. The learning outcomes derived from WAG-aided learning were higher than those derived from learning with no WAG aid, albeit with a few drawbacks (Yensi, 2020).

Some advantages of online learning are that it allows learning anywhere and at any time, promotes students' independence, allows a greater variety in learning, expands learning sources, and increases effectiveness in terms of time, cost, and labor (Firmansyah, 2021). The mathematics learning at STIKes IKIFA also utilized teaching materials in the forms of modules or handouts and learning videos that students might use independently. This research used data of students' learning outcomes in the mathematics course that was considered difficult, given that mathematical basics are of much importance to pharmacy students. With the use of a greater variety of media in online learning in the mathematics course, it is expected that the effectiveness of online learning may be increased. Therefore, it was considered necessary to conduct a research study on the effectiveness of online learning based on the mathematics learning outcomes of STIKes IKIFA students during the COVID-19 pandemic.

METHODS

The method employed in this research was a descriptive-quantitative one. The measuring instrument used was a 40-question multiple-choice mathematics test instrument. Prior to its usage, the test instrument had gone through validity and reliability testing involving 30 respondents. The validity test yielded a sig. value < 0.05 for each question, and the reliability test did a Cronbach's alpha score of $0.941 > 0.60$ (Nugraha, 2022). Therefore, the 40 questions were feasible to use. The results of the validity and reliability tests processed using the SPSS application are presented in Table 1 and Table 2.

Table 1. Validation results of mathematics test instrument

Case Processing Summary			
		N	%
Cases	Valid	30	100.0
	Excluded ^a	0	.0
Total		30	100.0

a. Listwise deletion based on all variables in the procedure.

Table 2. Reliability results of mathematics test instrument

Reliability Statistics	
Cronbach's Alpha	N of Items
.941	40

Data collection was performed by distributing the mathematics test instrument to 95 respondents sampled by the total sampling technique. This research used the one-group pretest-posttest research design (Mertens, 2005).

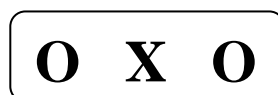


Figure 1. One-group pretest-posttest design

The lefthand O in Figure 1 shows the pretest score before online learning, with X being the six-week online learning intervention, and the righthand O shows the posttest score after online learning of the same group.

Learning effectiveness refers to the success attained upon the completion of a learning process in the achievement of an agreed upon learning objective (Sartika *et al.*, 2022). The learning effectiveness indicator used in this research was the achievement of the learning objective, that is, the rate of individual learning completion during online learning. Learning would be considered effective if a

student scored higher than 70 (good category) and if 80% of all students passed individually. Learning would also be considered effective if there was an increase in score from pretest to posttest that belonged to the moderate category. A gain score test was performed to calculate the difference between the pretest score and the posttest score. The formula for the gain score test is given in Equation (1) (Hake, 1998):

$$n \text{ gain score} = \frac{\text{posttest score} - \text{pretest score}}{100 - \text{pretest}} \quad (1)$$

This test aimed to find out whether there was an increase in learning outcome after the intervention was applied by first conducting a prerequisite test, namely, normality test (Wijaya *et al.*, 2021). The interpretation of the gain score is categorized into three types are presented in Table 3 (Hake, 1998):

Table 3. Gain score interpretation for mathematics learning outcome

Mean N-gain	Category
$(\langle g \rangle) \geq 0,7$	High
$0,7 > (\langle g \rangle) \geq 0,3$	Moderate
$(\langle g \rangle) < 0,3$	Low

RESULTS AND DISCUSSION

Prerequisite Test Data Analysis

This research's sample consisted of 95 students, and there were no missing data. The minimum and maximum pretest scores were 28 and 100, respectively. Meanwhile, the minimum and maximum posttest scores were 55 and 100, respectively. The posttest mean score was 87.40, greater than the pretest mean score, 74.74. This indicates an increase in students' mean score by 12.66. The posttest data were better distributed than the pretest data as the standard deviation of the posttest data was lower than that of the pretest data ($10.841 < 15.484$). A Kolmogorov-Smirnov test and a Shapiro-Wilk test were then conducted to gain information on the data distribution and to meet the requirement for conducting a data analysis. The former yielded a sig. value of 0.000, and the latter did the same sig. value, suggesting that the data were not normally distributed as the sig. values were < 0.005 (Herlina, 2019).

T-Test Results

A Wilcoxon test was conducted to examine the difference in mean between the two datasets in the case of abnormally distributed data (Norfai, 2021). The results showed that 12 respondents had negative ranks, meaning that they experienced drops in score after the posttest. Eighty-one respondents had increased scores after the posttest, and only two respondents experienced neither an increase nor a decrease from the pretest to the posttest. Descriptively, it is said that there was an increase in learning outcome as a result of online learning. This was supported by a sig. value (2-tailed) of $0.000 < 0.005$

from the Wilcoxon test, showing that there was a significant difference in student outcome after the implementation of online learning. This is consistent with the results of Yensi's research (2020), which found increased student outcomes after an online learning implementation.

Descriptive Analysis of Learning Outcome Data

From the gain score test conducted on each student, it was found that 28.421% of respondents belonged to the low category, 38.947% did the moderate category, and 32.632% did the high category. This diversity stemmed from the varied initial abilities and learning motivations of the students. As many as 28.421% respondents demonstrated increased scores within the low category as they admitted that they found it easier to understand the materials during face-to-face learning. Some also experienced problems with Internet connection during learning, causing them to miss some parts of the materials. The majority of other students favored online learning as it allowed them to learn at any place and cut the time spent for traveling to campus, the materials delivered were identical to those given during face-to-face learning, and it allowed them to relearn the materials at other times. The materials were easily accessed at any time, and there was a forum for discussion provided by the LMS. According to some previous works, online learning's advantages lie in flexibility in terms of time and place of study (Misran & Yunus, 2020) and in its ability to encourage students to learn independently (Sadikin & Hamidah, 2020).

On average, the increase in the students' outcomes was categorized as moderate. This is because the university and the lecturers had made their best effort to create a conducive learning environment although learning must be conducted online. It is important that online learning during the pandemic maximize active interactions between the lecturer and students and between a student and another student and that facilities be available to support it. STIKes IKIFA provided, among other facilities, a Zoom platform for a virtual, live meeting for each class to allow for two-way interactions like the interactions during face-to-face learning. As was found in a research work at Universitas Pembangunan Nasional Jawa Timur, students were in favor more of learning via Zoom as they could interact directly with the lecturer in the case where they needed to discuss a certain matter (Pratama *et al.*, 2021). Based on this finding, it is fair to say that online learning was effective.

STIKes IKIFA provided an LMS as a medium for lecturers and students to communicate with each other. The LMS also facilitated task assignment and submission. The LMS provided by the university appears in [Figure 2](#).

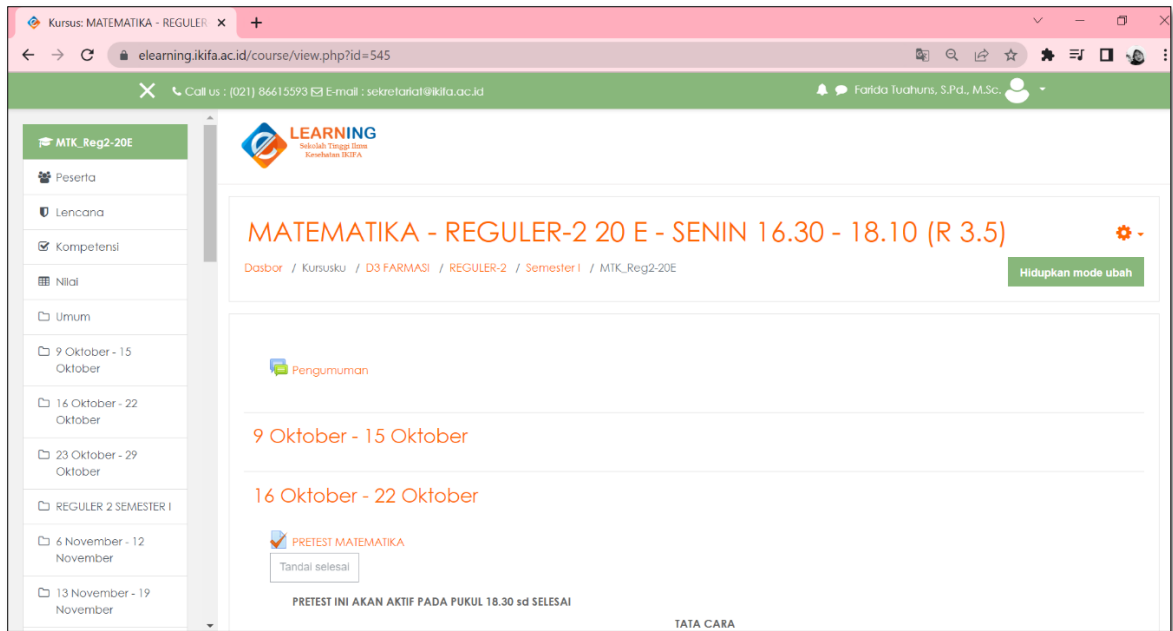


Figure 2. The appearance of the e-learning LMS of STIKes IKIFA

In addition, lecturers as facilitators distributed handouts in a language easy to understand to students. A handout example for the Equations of Straight Lines materials is provided in [Figure 3](#).

PERSAMAAN GARIS LURUS

Pada bab ini akan dibahas mengenai definisi persamaan garis lurus, gradien/kemiringan, cara melukis grafik fungsi linear hingga aplikasinya di dalam farmasi.

Sebelum kita mulai membahas lebih dalam mengenai aplikasi persamaan garis lurus dalam farmasi, perhatikan kasus berikut ini!

Kelarutan parasetamol dalam dalam suatu larutan tiap waktu ditampilkan sebagai berikut:

Waktu (t)	Konsentrasi (C_t)
0	2
1	4
2	6

Berdasarkan data tersebut dapatkah kamu menggambar grafiknya? Bagaimana cara menentukan persamaan garisnya?

A. PERSAMAAN GARIS LURUS

1. BENTUK UMUM PERSAMAAN GARIS LURUS

Fungsi linear merupakan fungsi yang memiliki variabel dengan pangkat tertinggi satu, dimana fungsi tersebut memetakan setiap $x \in R$ ke suatu bentuk $ax + b$ dengan $a \neq 0$, a dan b konstanta.

$$f: x \rightarrow ax + b \text{ atau } f(x) = ax + b$$

Figure 3. A handout example for the equations of straight lines material

Other than handouts, instructional videos were also provided by lecturers for students who intended to relearn from a past class. An earlier research work showed that instructional videos could help students understand materials and were effective to use in online learning (Wibawa & Payadnya, 2021). Therefore, it is expected that the instructional videos provided may help students achieve learning objectives. A lecturer might upload a recorded video to their personal YouTube channel, whose link was then disseminated through e-learning to all students of STIKes IKIFA. A screenshot of a learning video is provided in Figure 4.

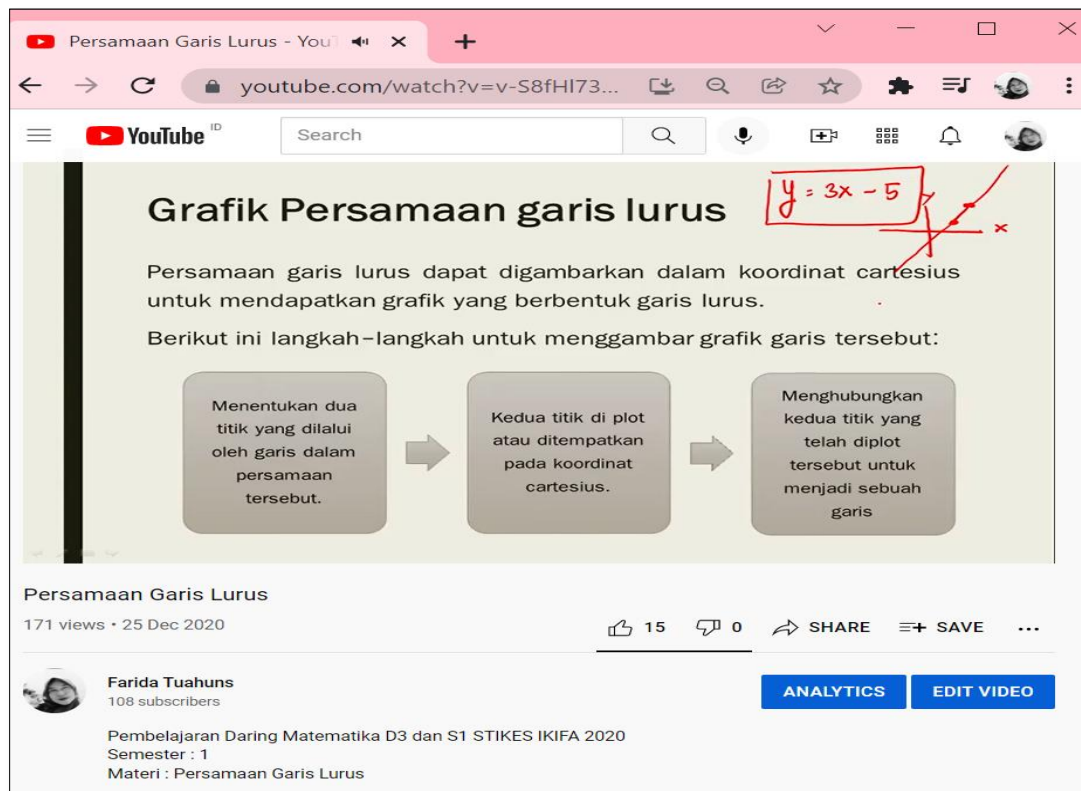


Figure 4. A screenshot of a learning video on the equations of straight lines material

A learning material in handout and PowerPoint slides forms is given to students prior to a class for the students to study in advance. During the class, the material was provided through either a lecture, a discussion, or a question and ask session to solve exercise questions, followed by an evaluation, and ended with a task assignment. The learning process was recorded by the lecturer to create an instructional video, which would later be uploaded on their YouTube channel. The video link was given to students during e-learning as a material to study later. In interviews, several students expressed that the learning videos and handouts provided by the lecturer were very helpful for their learning. The exercise questions given to the students were problems of applied mathematics for pharmaceutical calculations. Thus, it was expected that the students would not only have an understanding of a mathematical concept but also apply it in pharmaceutical calculations.

For the Equations of Straight Lines material, the first indicator is students performing pharmacy-related mathematical calculations. This indicator is represented by questions involving all numbers. The answers of a student that are presented in Figure 5 show that the student was able to answer all of the three questions correctly. In other words, the student had already had a good mastery of the equations of straight lines material. A student must not only know how to calculate mathematically, but also apply the mathematical calculations for pharmaceutical purposes. The second indicator, meanwhile, is students being able to determine equations of straight lines, which is represented by question 4 points a and b.

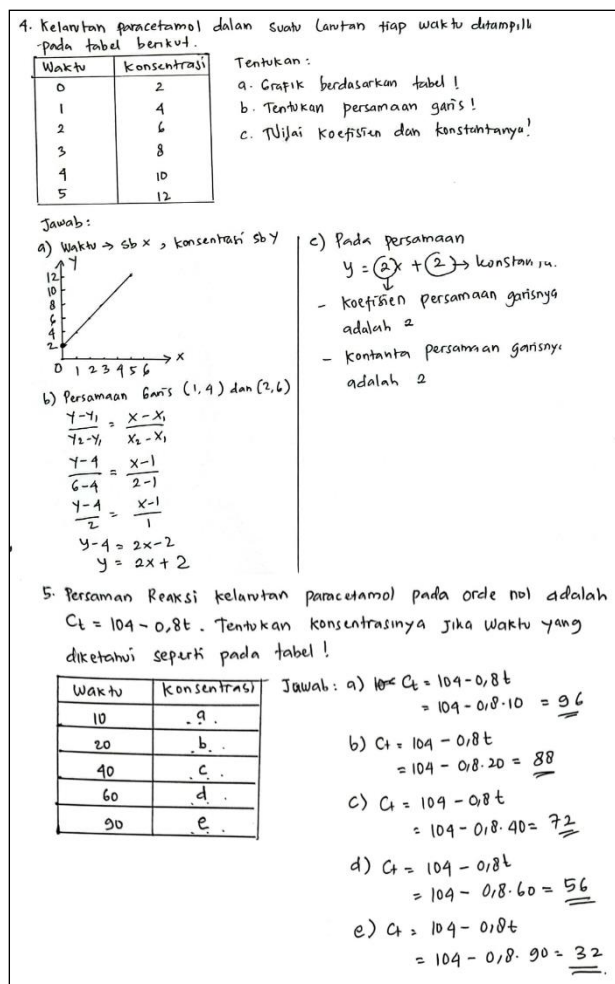


Figure 5. Another example of solutions to an exercise on the equations for straight lines

As shown in Figure 5, the student was able to draw a graph based on the data presented, determine the equation appropriate for the straight line created, and determine two points to be used to formulate a line equation. The third indicator is students being able to determine the gradient coefficient and constant of the equation of a straight line, which is represented by question 4 point c. Still in Figure 5 it is shown that the student was able to determine a gradient coefficient and discriminate it against the

constant of the equation of a straight line. Lastly, the fourth indicator is students being able to apply equations of straight lines for calculating drug doses.

Based on [Figure 5](#), the student was able to apply the equations of straight lines material according to a given reaction equation. However, some students also give incorrect answers to problems, such as creating a straight-line equation in response to question 4 point a. They omit connecting a points to a straight line and only display the points indicated on the Cartesian graph. Additionally, some students apply the formula incorrectly. They construct a line equation using the gradient formula. This is in line with earlier research, which discovered a number of challenges students encountered when learning about Equations of Straight Lines, including challenges understanding the questions and figuring out the best ways to approach and solve problems. (Umam *et al.*, 2017).

Pretest scores revealed that, prior to the online learning intervention, 67.4% of students scored above 70. After online learning, however, as shown by posttest scores, 92.7% of students successfully exceeded the score of 70. In other words, there was an increase of 25.3%. Learning would be considered effective if students exceeded the score of 70 and if 80% of all students passed individually. The fact that 92.7% of all students scored in excess of 70 means that the online learning conducted was effective. Learning effectiveness refers to the success attained upon the completion of a learning process in the achievement of an agreed upon learning objective (Sartika *et al.*, 2022). The learning effectiveness indicator used in this research was the achievement of the learning objective, that is, the rate of individual learning completion during online learning

CONCLUSIONS

In this research, learning effectiveness was considered based on two indicators, namely, an increase in learning outcome and student completion rate. With regard to the first indicator, the pretest and posttest results showed that 85.26% of students had increased learning outcomes. Meanwhile, with regard to the second indicator, a total of 92.7% of students scored higher than 70. Therefore, it is concluded that, as a whole, the online learning conducted at STIKes IKIFA was effective, given that it had met the two indicators of learning effectiveness above. This effectiveness was owed to a fairly good collaboration between the university, the lecturer, and the students in creating a conducive learning condition in the midst of the COVID-19 pandemic.

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