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Research Article

The effectiveness of online learning in the mathematics and sciences department: in learning biology

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ABSTRACT
Since the COVID-19 pandemic, online learning has become commonplace, but the effectiveness of online learning has never been evaluated; therefore, it is necessary to evaluate the effectiveness of online learning. This descriptive study aims to describe the effectiveness of online learning for lecturers and students of the Biology Education Study Program, FKIP Unsri, with a sample of 140 students and 16 lecturers in the odd semester. The study results show that online learning from the aspects of support, facilities and infrastructure, stakeholders, learning processes and student achievement indexes is included in the effective category. The platforms that are often used by students and lecturers besides Unsri e-learning are Google Classroom and several supporting platforms such as Zoom Cloud Meeting and WhatsApp. Applications and platforms, and online-based learning can still be used even though the pandemic has ended, because the online-based learning process is still better when combined with offline learning, which can facilitate direct interaction between students and teachers.

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Introduction

The covid 19 pandemic forces us to study from home or online learning. The government made a new policy in the form of limiting community social interaction which in the end had an impact not only on the economic and social fields but also on the education sector (Barbour et al., 2020; Borup et al., 2020; Mustakim, 2020). Since Indonesia was officially affected by the corona virus, it requires online learning to replace face-to-face conventional learning so that students continue to receive learning (Herliandry et al., 2020), the teacher's ability to integrate technology will greatly affect the online learning process.

The pandemic has only become our trigger to be able to develop online learning, it is not an obstacle to continuing the learning process in the classroom. Every university will definitely make innovations to continue to carry out the learning process even though not through face-to-face meetings. One of them is Sriwijaya University, which always strives to innovate in dealing with the pandemic and other similar challenges or obstacles in the learning process. Since Indonesia has been affected by the corona virus, one of the efforts made by Sriwijaya University especially Biology education

program to keep the learning process going is by conducting lectures online. Based on observations of online learning experiencing various obstacles including not all students easily accept online learning. The pattern of learning that was previously carried out face-to-face to online makes it difficult for students to adapt from various factors such as unstable network connections, especially plus students who are in areas far from residential areas, limited student quotas and are required to have readiness in learning. In addition, the character of biological material that is close to life requires contextual learning. There are several biology materials that must be explained through practicum. One of the solutions used is the use of a virtual lab, which is considered successful in distance learning.

To retain as much of the hands-on lab training as possible, even in an online learning environment, our faculty pursued instructional innovations with varying degrees of success. Some of these tools, techniques, and approaches were discarded with the return to in-person classes, but most of them were retained, in whole or part, because they had the potential to improve the students' experience of the in-person learning environment as well. Others have also found that while virtual labs alone cannot adequately substitute for in-person experiences, virtual tools, in combination with physical experiences, can be particularly effective (Smith, 2021; Son et al., 2016). The characteristics of the material in biology content require a lot of practicum, judging from the aspect of the media used, of course some universities have certain policies regarding subjects that require experimentation, making projects, teaching practice and so on.

Online learning is learning carried out by teaching staff with students at different times and locations with the same goal and its implementation utilizing the internet network (Baber, 2023). Based on the results of previous studies, Online lecture activities are influenced by learning models with several approaches such as learning media, communication models and appropriate learning styles. whatever the conditions, if the teacher or lecturer can carry out the learning process professionally by adapting and innovating by combining learning models with technology, of course all learning processes will run well. lecturers who have been teaching for a long time will certainly easily adapt some learning strategies well. Anwar et al. (2014) said that a teacher must be able to adapt to any situation, they should also behave acquired special knowledge from the teaching process that has been carried out many years and from development profession. By choosing the right learning model, technology, online lectures run smoothly and effectively (Anwar et al., 2014).

Apart from using teaching strategies, using the right digital platform can help in understanding the material (Syahfitri & Herlina, 2022). In online learning, teacher competence also plays an important role in obtaining student competency, because Biology contains many abstract concepts (Cimer, 2019). Teachers are expected to be digitally competent because online learning requires these competencies so that they are able to develop existing digital competencies in students for the purpose of better understanding and application in the field of science, especially biology or science

subjects. One thing that teachers can do in teaching online is to use the e-learning system which is used as a tool to assist the learning process and increase students' understanding of receiving material (Bulic & Blazevic, 2020).

On the other hand, online learning has many drawbacks. This is supported by several studies related to the effectiveness of online learning. Based on study results (Maulana, 2021) research shows that 94% or 27 students out of 28 students did not complete and when viewed from the activeness of students in participating in learning only 38% and this made learning ineffective (Anwar et al., 2014). Learning is considered less effective because the learning objectives have not been achieved due to the unavailability of supporting information technology facilities, the ability to use technology, and the unstable condition of the internet network (Dziuban et al., 2018; Panggabean et al., 2021).

In the same study, (Mustakim, 2020) further explained that the obstacles faced during online learning were as many as 66.7% of students experienced problems on an unstable internet network, 66.7% of students said that the task was too much, 56, 7% of students find it difficult to focus, 53.3% of students experience problems with limited internet quotas, complicated platforms used, and prefer face-to-face learning. The learning process has also implemented discussions, quizzes, individual assignments, lectures, learning videos, and group assignments. Thus, online learning is still carried out even though it has some limitations.

Based on the research of (Jamaluddin et al., 2020) In the online learning process 65% of the material obtained by students is more than sufficient and 30% stated that during the online learning system the information obtained in lectures was lacking. This is caused by the teaching method used during learning. During online learning, understanding material with instructions that have been explained is a challenge so that some students find it difficult to understand lecture material. There are several courses whose material requires in-person lectures and using this online system is felt to be more difficult, for example in the Embryology course in the Biology Education Study Program. Therefore, the selection of the right media must be made by the lecturer and adjusted to the subject being taught. And this is a challenge for lecturers and students.

Meanwhile, based on research by (Rohmawati, 2015), the effectiveness of learning is marked by the success of delivering students to achieve the learning objectives that have been set, involving students actively to support the achievement of teaching goals, providing an attractive learning experience, and having facilities that support the teaching and learning process. Korthagen (2017) effective learning from the view of students activities in learning include communication and mastery of learning materials, in addition to complete learning outcomes, responses or interests of students, and do not experience difficulties in implementing learning online. Student success online is highly dependent upon engagement and the types of learning activities used (Bae Kwon et al., 2019; Hung et al., 2020; Ma et al., 2022; Roblyer et al.,

2008). Web based-biology learning requires a solid infrastructure system such as computer hardware and internet connection (Vekli & Çalik, 2023).

There are many learning platforms that have emerged as a result of the pandemic, of course these applications must be evaluated whether they can continue to be used even though the pandemic is over? or is not able to support the teaching and learning process in the future. When viewed from the aspect of learning, online learning has several advantages and disadvantages. Web-based lectures do have disadvantages, including lack of visual cues and feedback which help teachers evaluate understanding (Miller, 2008). Therefore, the online learning process, which is not used to being done, really needs to be evaluated, is this online learning effectively implemented?

Of course, every university will be different in dealing with a pandemic and each will have different challenges and obstacles, especially those faced by lecturers and teachers in the learning process, some are effective and some are not. Since the beginning of the pandemic, Unsri has implemented a blended and hybrid learning process, which is then fully online because the pandemic is getting higher. Blended and hybrid learning there are no problems in the implementation of learning, but what if the learning process is carried out in full online, this still needs to be evaluated further. Even though UNSRI has prepared a learning platform (e-learning UNSRI), is it enough to just use that platform, and can it run effectively?. Therefore, this study aims to evaluate the effectiveness of online learning in the Biology Education Program at FKIP Unsri. The study seeks to assess various aspects including the availability and support of facilities and infrastructure, the roles and readiness of stakeholders (such as lecturers and students), and the overall quality and continuity of the online learning process within the program. The effectiveness of learning will be assessed from several aspects including of support facilities and infrastructure, stakeholders, and the learning process in the Biology Education Program, FKIP Unsri.

Method

This research needs to be carried out so that it can be known whether during the covid-19 pandemic there was a problem or a success that could affect biology learning so that the effectiveness of the application of online learning in the Biology Education Study Program, FKIP Unsri. This research is only limited to observing the effectiveness of the aspects of support, facilities and infrastructure, stakeholders, learning process and student achievement index using the questionnaire that were made.

This research will be carried out in the Biology Education Program, Faculty of Teacher Training and Education, Sriwijaya University. The population in this study were lecturers and students of the Biology Education Program, FKIP Unsri. The sampling technique in this study used a random sampling technique. To determine the number of samples to be used, the researcher used the Slovin formula. From a population of 17 lecturers and 216 students, the sample was 16 lecturers and 140 students at Biology Education Program in a state university in Palembang, Indonesia. 16 lecturers consisted of teaching staff with average age of 35 until 61 and 5 until 20 years in teaching

experience average. 140 students come from three academic class, with 72 students comes from 2018 class or fourth year students, 71 students from 2019 class or third year students, and 73 students from 2020 class or second year students.

The research procedure starts from the planning and preparation stages, to implementation and completion. At the preparation stage, namely preparing a research instrument in the form of a questionnaire which will be distributed via a google form link and interview guidelines for some of the results of the questionnaire which must be explained further, especially regarding biological content that requires experimentation. Furthermore, at the implementation stage, namely distributing questions to lecturers and students in the form of a questionnaire and distributing it via a google form link.

And the completion stage is in the form of processing data and analysing the data that has been obtained from the results of the questionnaires that have been distributed, then interviews with lecturers regarding biology content material will be conducted.

Table 1. Student questionnaire grid

Indicator	Sub-Indicator	Criteria	Question
Support	Facilities and Infrastructure	Platforms	1, 2
		Signal	3
		IT Literacy	4, 5
	Stakeholders	Institution	6, 7, 8, 9, 10, 11, 12
		Student guardian	13, 14, 15
Learning Process	Task	Individual	16, 17
		Group	18, 19
	Comprehension	Individual	20
		Group	21
	Teaching materials	Individual	22, 23
	Interaction	Individual	24, 25

The completion stage is in the form of processing data and analysing the data that has been obtained from the results of the questionnaires that have been distributed, then carrying out a descriptive analysis related to the research that has been carried out, then the results of the analysis are discussed and concluded so that the desired research results are obtained. The indicators of effectiveness consist of support in the form of facilities and infrastructure, platform, stakeholders, and indicators of the learning process in the form of giving assignments, understanding, teaching materials and interactions (Dewa et al., 2020; Farkhani et al., 2022; Mandasari et al., 2020; Wang et al., 2023). Data collection techniques carried out in this study were through questionnaires. Questionnaire data analysis was conducted to determine the effectiveness of online learning through there sponges of lecturers and students who can be influenced by infrastructure during online learning, the learning process during online learning, as well as support from institutions, lecturers and student guardians in

online learning. Data analysis was done manually by calculating the results of the answers and the unconverted in percentages. The questionnaires a closed question using the Guttman scale.

The level of effectiveness in online learning can be seen from the value of the interpretation criteria in the table as follows:

Table 2. Guttman scale interpretation criteria

Assessment	Interpretation
0% - 20%	Very ineffective
21% - 40%	Ineffective
41% - 60%	Effective enough
61% - 80%	Effective
81% - 100%	Very Effective

The instrument that will be measured in this research is the effectiveness of the implementation of online biology learning. Before making an instrument, an instrument grid needs to be made in order to facilitate the development of instrument manufacture. Questions given to the questionnaire for students as many as 25 questions and 22 questions for lecturers. The questions consist of sub-indicators, namely facilities and infrastructure, stakeholders, tasks, understanding, teaching materials and interactions

Results and Discussion

The novelty of this study explores the effectiveness of the aspects of support, facilities and infrastructure, stakeholders, learning process and student achievement index that described one unit per indicator.

Description of platforms that are widely used besides UNSRI e-learning

The results of student and lecturer answers regarding platforms that are widely used other than Unsri e-learning during online learning will be converted in the form of percentages. Furthermore, the percentage results are displayed in the form of images as shown in Figure 1 and Figure 2. The percentage of platforms that are widely used by students during online learning can be seen in Figure 1 below.

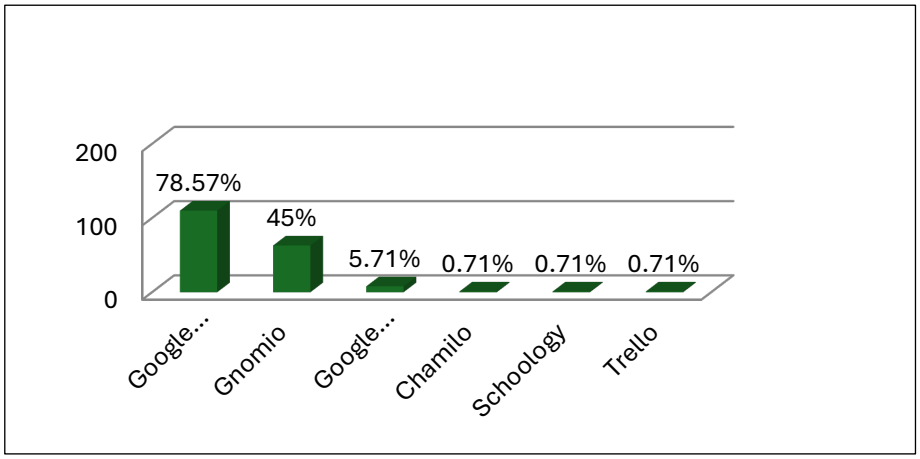

Figure 1. Percentage of platforms that are widely used by students during online learning

In addition to using the Unsri LMS, there are several other platforms that are used to support the teaching and learning process, including those listed on Figure 1 ,the platform that is widely used by students is Google Classroom with a percentage of 78.57% and the platform that is slightly used, consisting of Schoology, Chamilo and Trello with a percentage of 0.71%. In addition to Google Classroom , there is also the Gnomio platform with a percentage of 45% used by students. The order of preference levels for platforms that are widely used by students during online learning apart from Unsri e-learning from the most used to the never used are Google Classroom, Gnomio, Google Teams, Chamilo, Schoology and Trello. Then the percentage of platforms that are widely used by lecturers during online learning can be seen in Figure 2 as follows.

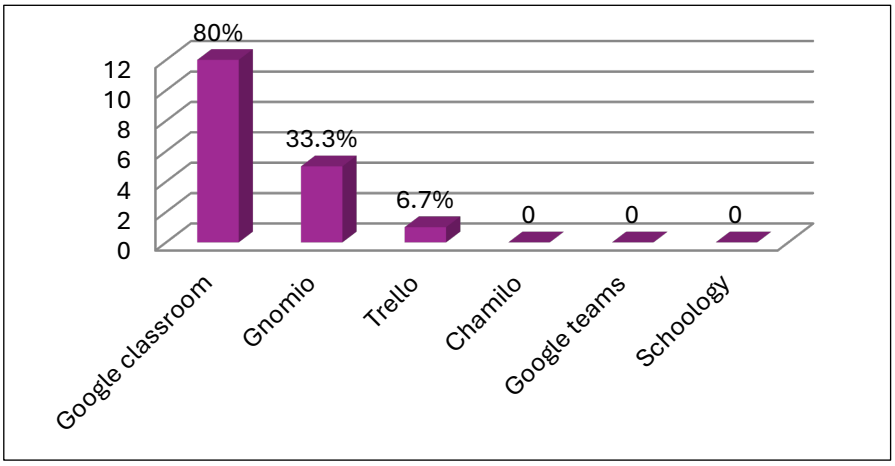

Figure 2. Percentage of platforms that are widely used by lecturers during online learning

Based on Figure 2, the platform that is widely used by lecturers during online learning is no different from students, namely the google classroom platform with a percentage of 80%. The platforms that were never used were Schoology, Camilo and google teams because there were no lecturers who chose these platforms as the answer to the platforms that were widely used. The order of preference level for platforms that are widely used is Google Classroom at 80%, Gnomio 33.3%, Trello 6.7% and platforms that are never used are Camilo, Schoology, and Google Teams.

Google Classroom is the most used because it is a free web-based platform. Google classroom makes it easy to create classes, distribute assignments, communicate, and stay organized. Teachers can quickly see who has or hasn't completed the work, and provide direct, real-time feedback and grades right in Google Classroom. Assignments appear in your Google Calendar. The most common reason for the choice of an online learning platform are accessibility and affordability, for example lecturers can link virtual lab videos that students can study and can directly discuss through forums that have been provided by google classroom directly. Google Classroom improved the reading and writing performance of Syrian students. Students showed positive attitudes toward using Google Classroom in terms of its ease of use, usefulness, and accessibility (Albashtawi & Al Bataineh, 2020).

Description of the lecture support platforms used during online learning

Platforms used during online learning are converted into percentages, which can be seen in Figure 3 and Figure 4 below. The percentage of lecture support platforms used by students during online learning can be seen in Figure 3 below.

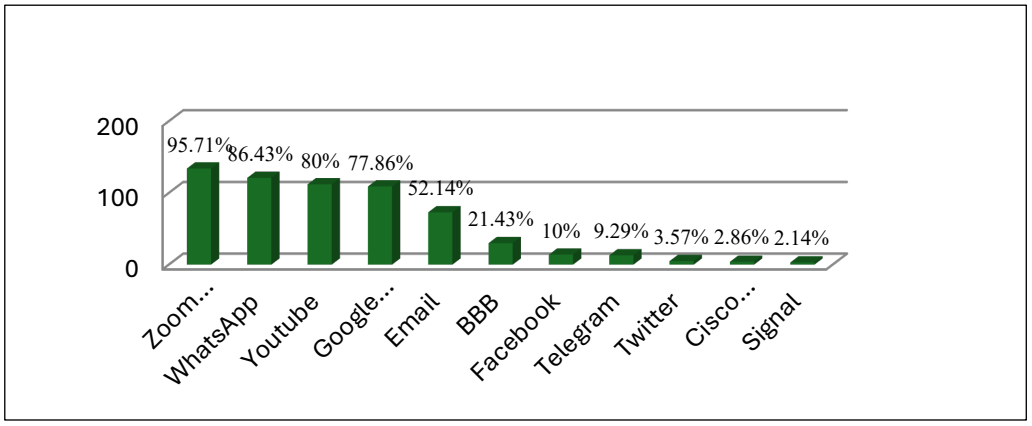

Figure 3. Percentage of platforms supporting student lectures during online learning

Based on Figure 3, it shows that there are several lecture support platforms used by students during online learning. The zoom cloud meeting platform is the platform with the highest level of preference, which is 95.71%, thus it can be said that the zoom cloud meeting platform is a platform that is widely used by students as a support platform during lectures. In addition, there is also WhatsApp with a percentage of 86.43% and the YouTube platform with a percentage of 80%. The platform with a low level of preference is the signal platform, which is 2.14%, so it can be said that this platform is a platform that is rarely used. The order of platforms that are widely used by students to those that are used a little by students based on their level of preference are zoom cloud meeting 95.71%, WhatsApp 86.43%, YouTube 80%, google meet 77.86%, email 52.14%, BBB 21.43%, Facebook 10%, telegram 9.29%, twitter 3.57%, cisco Webex 2.86%, and the final order is platform signal with a percentage of 2.14%.

From the interview results, several reasons for lecturers to use these platforms are, “we prefer the Zoom and WhatsApp applications is because they are very easy and efficient to use, there are no difficulties in using them”. both students and lecturers choose the zoom application for synchronous learning and WhatsApp for asynchronous learning. While for YouTube reasons they said that “... through YouTube, we can not only take several sources to be used as learning materials (e.g. Virtual lab) but can also link assignments, for example, teaching practice, experimenting, making projects or certain products by recording them and then linking them on YouTube, ours assessment is also assisted by the number of people who like and subscribe to that video and the average value is good, the assessment we do must be fair, because we don't do practicum so the assessment also doesn't assess skills like during real practicum”. Furthermore, the lecturers said that "for certain materials, the virtual lab would be better if combined with the real lab".

In addition, the conversion results from students also show that there is also a supporting platform used by lecturers during online learning lectures which can be seen in Figure 4 below.

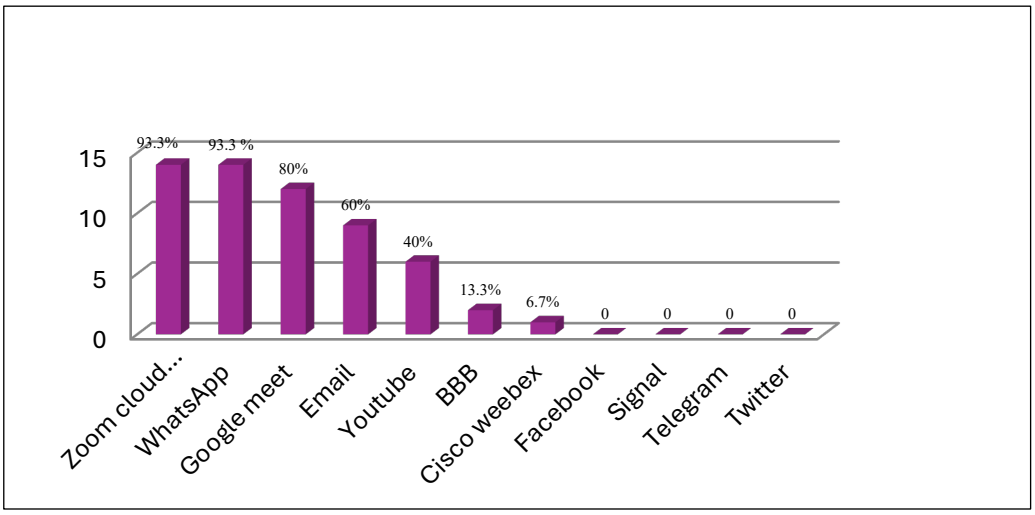

Figure 4. Percentage of supporting platforms used by lecturers during online learning

Based on Figure 4, the supporting platforms that are widely used by lecturers with the highest percentage level are zoom cloud meeting platforms and WhatsApp, which are 93.3%, this is no different from that used by students. In addition, the Google Meet platform with a percentage of 80% includes a widely used supporting platform. In contrast to students, on the Telegram, Signal, Facebook and Twitter platforms, which are platforms with a percentage rate of 0%, it means that no one uses this platform as a support platform during online learning lectures. The following is the order of supporting platforms that are widely used until those that are never used, namely zoom cloud meeting, WhatsApp, google meet, email, YouTube, BBB, cisco Webex, telegram, Facebook and twitter signals.

Description of the effectiveness of the support indicators

The effectiveness of the support indicators for students and lecturers during online learning is converted into percentages, which can be seen in Table 4 below.

Table 3. Effectiveness of support indicators for students and lecturers during online learning

No.	Statement	College student		Category	Lecturer		Category
		Yes	No		Yes	No	
1.	Adequate network connection	42.14%	57.86%	Effective enough	86.7%	13.3%	Very effective
2.	Lecturers who teach are able to use IT well	90.71%	9.29%	Very effective	-	-	-
3.	Students and lecturers concerned are	73.57%	26.43%	Well	53.3%	46.7%	Pretty good

No.	Statement	College student		Category	Lecturer		Category
		Yes	No		Yes	No	
	able to use IT well						
4.	Already have an online learning guide	68.57%	31.43%	Effective	100%	0%	Very effective
5.	The online learning process at FKIP is appropriate	68.57%	31.43%	Effective	86.7%	13.3%	Very effective
6.	Ministry of Education and Culture free quota	52.14%	47.86%	Effective enough	53.3%	46.7%	Effective enough
7.	Free quota usage	57.86%	42.14%	Effective enough	40%	60%	Ineffective
8.	Free quota is in accordance with the needs	19.29%	80.71%	Very Ineffective	33.3%	66.7%	Ineffective
9.	E-learning training	66.43%	33.57%	Effective	93.3%	6.7%	Very effective
10.	Understanding of e-learning training	67.86%	32.14%	Effective	93.3%	6.7%	Very effective
11.	Provision of learning tools from student guardians	95.71%	4.29%	Very effective	-	-	-
12.	Provision of quotas from student guardians	90%	10%	Very effective	-	-	-
13.	Special study room	36.43%	63.57%	Ineffective	40%	60%	Ineffective
	Average	90%	10%	Very effective	60%	40%	Effective enough

Based on Table 3 shows the results that the level of effectiveness of the indicators of support for students during online learning is very effective with a percentage of 90%. This is evidenced by the response of students who filled out the questionnaire by stating that the indicators of support for students are very good, this can be seen in the adequate network connection with a percentage of 42.14% with a fairly effective category, lecturers who teach are able to use IT well the percentage is 90.71% with a very effective category, the student concerned is able to use IT well, namely the percentage of 73.57% in the good category, already has an online learning guide with

a percentage of 68.57% in the effective category, the online learning process at FKIP is in accordance with the percentage 68.57% in the effective category, free quota from the Ministry of Education and Culture with a percentage of 52.14% in the quite effective category, the use of free quota with a percentage of 57.86% in the quite effective category, the free quota in accordance with the needs with a percentage of 19.29% in the very ineffective category, the existence of e-learning training with a percentage of 66.43% in the effective category, gamer e-learning training staff with a percentage of 67.86% effective category, provision of learning tools from student guardians with a percentage of 95.71 very effective categories, provision of quotas from student guardians with a percentage of 90% in the very effective category, and having a special study room with a percentage of 36.43% with ineffective category. While the level of effectiveness on the indicators of support for lecturers during online learning is categorized as quite effective with a percentage of 60%. This is evidenced by the response of the lecturers who filled out the questionnaire by stating that the indicators of support for lecturers were quite good , this can be seen in the adequate network connection with a percentage of 86.17%% (quite effective), the lecturer concerned is able to use IT well, namely the percentage 53.3% (good enough), already has an online learning guide with a percentage of 100% (very effective), the online learning process at FKIP is in accordance with the percentage of 86.7% (very effective), free quota from the Ministry of Education and Culture with a percentage of 53.3% (quite effective) , the use of free quota with a percentage of 40% (ineffective), free quota is in accordance with needs with a percentage of 33.3% (ineffective), e-learning training with a percentage of 93.3% (very effective), understanding of e-learning training with a percentage of 93.3 % (very effective) and has a special study room with a percentage of 40% (not effective). a special room is not really needed because without a special room online learning can take place well.

Description of the effectiveness of the indicators of the learning process

The effectiveness of the indicators of the learning process for students and lecturers during online learning is converted into percentages, which can be seen in Table 5 below.

Table 4. The effectiveness of the indicators of the learning process for students and lecturers during online learning

No.	Statement	College student		Category	Lecturer		Category
		Yes	No		Yes	No	
1.	Independent assignments according to the material	93.57%	6.43%	Very effective	-	-	-
2.	Response to self-assignment	90%	10%	Very effective	-	-	-
3.	Group assignments	97.86%	2.14%	Very effective	-	-	-

No.	Statement	College student		Category	Lecturer		Category
		Yes	No		Yes	No	
	according to the material						
4.	Responses to group assignments	87.14%	12.86%	Very effective	-	-	-
5.	Giving feedback on independent assignments	-	-	-	86.7%	13.3%	Very effective
6.	Giving feedback on independent assignments	-	-	-	86.7%	13.3%	Very effective
7.	Understanding of independent tasks	86.43%	13.57%	Very effective	93.3%	6.7%	Very effective
8.	Understanding group assignments	90.71%	9.29%	Very effective	93.3%	6.7%	Very effective
9.	Understanding of teaching materials	84.29%	15.71%	Very effective	-	-	-
10.	Teaching materials delivered	76.43%	23.57%	Effective	-	-	-
11.	Preparation of teaching materials for independent activities	-	-	-	100%	0%	Very effective
12.	Preparation of teaching materials in group activities	-	-	-	86.7%	13.3%	Very effective
13.	Interaction between lecturers and students	85%	15%	Very effective	93.3%	6.7%	Very effective
14.	Interaction between students	74.29%	25.71%	Effective	80%	20%	Effective
	Average	88%	12%	Very effective	90%	10%	Very effective

Based on Table 4 shows the results that the indicators of the learning process for students during online learning are categorized as very effective with a percentage of 88%. This is evidenced by the results of student responses to indicators of the learning process for students during online learning is very good, this can be seen from independent assignments according to the material with a percentage of 93.57% (very effective), lecturer responses to independent assignments with a percentage of 90% (very effective), group assignments given by lecturers according to the percentage of material 97.86% (very effective), responses to group assignments 87.14% (very effective), understanding of independent assignments and group assignments with very effective categories, student understanding of teaching materials percentage 84.29% (very effective), percentage of teaching materials delivered is 76.43% (effective), interaction between lecturers and students and students and students are 85% (very effective) and 74.29% (effective). While the indicators of the learning process for lecturers during online learning are categorized as very effective with a percentage of 90%. This is evidenced by the results of the lecturer's response to the indicators of the learning process for lecturers during online learning is very good , this can be seen from the response to independent assignments and student groups the percentage of 86.7% (very effective), students' understanding of independent assignments and the percentage of groups 93.3 % (very effective), preparation of lecturers for teaching materials in independent and group activities with very effective categories, interaction between lecturers and students and students with percentages of 93.3% (very effective) and 80% (effective).

Online learning provides benefits, can make students learn independently and become an alternative method of learning that does not require being present in class, besides that online learning lecturers can change the teaching style in the classroom which has an impact on the professionalism of the lecturer's work (Wang et al., 2023). Other research says that online learning is considered effective because learning can be accessed anywhere and anytime besides that it can increase student motivation (Sadikin & Hamidah, 2020).

There are several factors that can make online learning successful, teachers characteristics, students characteristic and technology. The important factors to consider in online learning in biology learning environments include transmission of course material and inclusion of content-based student assignments and activities. We present some of our own practices and experiences with these factors, and review the current literature. The convenience of online lectures may contribute to the overall satisfaction students attribute to distance learning (Walker & Kelly, 2007). From the results of interviews with lecturers... 'in terms of infrastructure it may be sufficient but it is better to hold training related to digital technology for us'. They need the latest digital technology information for the online learning process, especially biology material that must be carried out experiments or practicums so that they can create virtual labs easily and efficiently

For biology content that has to carry out experiments, lecturers must work harder to prepare virtual experiments obtained through YouTube or make them themselves, lecturers can also assign students to make virtual experiments and their reports. In Unsri, for some biological content that is difficult to virtualize, experiments can be carried out with student restrictions and the use of the covid 19 procedure. With this online learning, prospective teachers are not only experts in delivering material offline (face to face in class) but they also become accustomed to mastering systems with online technology-based learning. This online learning system can be the first step for prospective teachers to prepare for online-based learning and optimize existing technology. The future learning will combine online and offline learning at the same time. combining real and virtual experiments, apart from the individual affordances and the learning objectives of the different experiment types, especially their specific function for the learning task must be considered (Wörner et al., 2022). In recent years, such analogue forms of experimentation have been enhanced with, and sometimes even replaced by, digital technologies (Becker et al., 2020; Brinson, 2015). Effective online learning requires technology infrastructure, platforms, software, and professional development programs for teachers, a positive attitude, and a willingness to accept technology. In addition to these IT Technology-related and institutional factors, teachers' perceptions of the importance of online education, digital literacy and participation in online activities play an important role in providing optimal and effective instruction.

Description of Obtaining Semester Achievement Index (IPS) of students in the Biology Education Program, FKIP Unsri

The Semester Achievement Index (IPS) of students in the Biology Education Program, can be seen in table 5.

Table 5. Learning Outcomes (IPS) of Biology Education students, FKIP Unsri

No	IPS	Predicate	Frequency	Percentage
1	3.51 – 4.00	Praise	105	75%
2	3.01 – 3.50	Very satisfactory	33	23.57%
3	2.76 – 3.00	Satisfying	2	1.43%
	Amount		**140**	**100%**

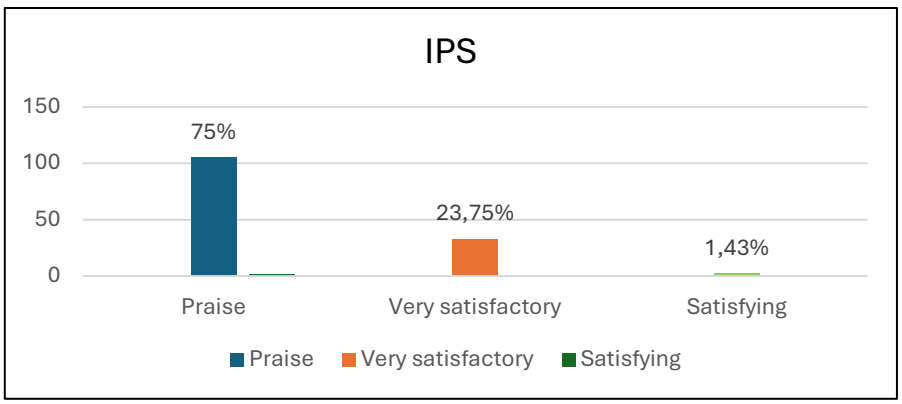

Figure 5. IPS Group Diagram of Learning Outcomes

Based on the results of Table 4 and Figure 5 a list of Semester Achievement Index (IPS) or learning outcomes, it can be seen that biology education students who get a semester achievement index (IPS) scores 3.51 – 4.00 with honour's were 105 people with a percentage of 75%, as many as 33 students with a percentage of 23.57% get IPS scores 3.01 – 3.50 with very satisfactory predicates and with a percentage of 1.43% with a total of two students getting IPS scores 2.76 – 3.00 with satisfactory predicates.

During the pandemic, there is no reason for student learning outcomes to decline. By optimizing online learning, there must be readiness to learn and have a passion for learning and high motivation. The enthusiasm for learning has a very important relationship to learning activities so that student learning outcomes become good. And students and lecturers are required to optimize existing technology which becomes a bridge in transferring knowledge from lecturers to students.

In a study, it was found that E-Learning may be effective in developing cognitive abilities. Many Online programs are offered by some of the most prestigious universities from all around the world. The students can take such an online course which can be helpful for the development of his cognitive abilities, but for subject matter that must be carried out experiments it is better to combine online and offline learning. In most cases combinations of real and virtual experiments promote conceptual understanding better than a single type of experimentation (Wörner et al., 2022). Instructional Technology is highly beneficial for students, especially students pursuing a professional course. Mehra (2017) said that online learning is considered a boon due to the reason; Accessibility, personalized learning, develops cognitive abilities, promotes research, Cost-effectiveness, self-pacing, and globalization. There are two sides of the same coin. Online learning also shows its other not so good sides.

Online learning is not only used during the Covid 19 pandemic, the pandemic has only become our trigger to be able to develop online learning. In the future, the online learning system can be implemented by considering several things, including lecturers and students who are expected to increase literacy insights into online learning, create blended, online and face-to-face patterns in normal lectures. so that learning can be carried out optimally. Suyanto et al. (2022) said that ICT increases students' conceptual knowledge, Online learning uses ICT to bridge student and teacher interaction. Learning in online settings may pose additional challenges to students' motivation to learn and require them to exercise self-discipline in their learning behaviours to a greater degree than in face-to-face learning settings (Carter et al., 2020). Web-based biology learning environment is somewhat effective at improving the students' academic performance (Vekli & Çalik, 2023).

Conclusion

Effective online learning in contexts requires technology infrastructure, functional platforms, software, teacher pedagogy, digital literacy, and a willingness to accept technology. Based on the results of research on the effectiveness of online learning from the aspects of support, facilities and infrastructure, stakeholders, and the learning

process in the Biology Education Study Program FKIP Unsri, it can be concluded that it is effective. as seen in the results of data analysis, the data acquisition platform that is widely used by students and lecturers besides Unsri e-learning (LMS Unsri) during online learning is Google Classroom, which is a platform to support lectures during online learning used by students and lecturers is Zoom and WhatsApp cloud meeting platform. To achieve all aspects of learning outcomes, the combination of off-learning and online learning is still better (Blended learning), especially for certain biology materials. These applications and platforms can still be used even though the pandemic has passed. Future research should further examine how online learning is for materials that require experimentation.

Conflict of Interest

No potential conflict of interest was reported by the author(s).

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