Elinvo (Electronics, Informatics, and Vocational Education) ISSN 2580-6424 (printed) | ISSN 2477-2399 (online)
Vol 9, No. 1, 2024, pp. 52-63

Improvement of Performance E-Learning Moodle Service in Vocational High School with Optimization of Web Server and Database Server

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Article Info

Article history:
Received February 14, 2024
Revised April 29, 2024
Accepted May 21, 2024

Keywords:
System optimization; web server; database server; moodle; e-learning

Abstract

Since COVID-19, online learning has taken on an increasingly prominent role. Moodle is a popular online learning platform. Its implementation necessitates various support components, including a web server and an e-learning database server. The purpose of this study is to examine the optimization of web servers and database servers when there are multiple large connections at SMK N 2 Depok's E-learning. A pre-experimental one-group pretest-posttest design was used to conduct experimental research before and after optimization. Response time and throughput performance variables are used to assess performance on the Web Server, whereas response time and transaction per second performance are measured on the Database Server. The tools utilized in this study were Apache Benchmark and Sysbench. The population in this study was 2180 active users, with a total sample of 338 connections to access e-learning. The results of this research indicate that the performance of the Moodle e-learning web server can be optimized by tuning the web server configuration. There was a significant increase in performance on the web server after optimization. The performance of the moodle e-learning database server performance can be optimized by optimizing the database server configuration tuning. There is a significant increase in the performance of the database server after optimization. To use e-learning efficiently when using several connections at the same time, the web server and database server must be optimized through server tuning. This can boost the effectiveness of e-learning in the classroom. As a result, e-learning developers should consider optimizing e-learning server settings.

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INTRODUCTION

E-learning has experienced significant changes due to the COVID-19 pandemic [1]. The number of positive cases of COVID-19 on April 25, 2020, confirmed as many as 8,607 positive cases in Indonesia [2]. Due to the spike in the growth of cases of the spread of COVID-19, in several areas a Large-Scale Social Restriction policy was implemented. The result of this policy, several sectors such as business, tourism, and the economy were closed [3]. This has resulted in business activities that are difficult to get income, and several companies are forced to lay off workers [4]. The education sector is also inseparable from policies during the COVID-19 pandemic, based on the Minister of Education and Culture Decree Number 4 of 2020 concerning the Implementation of Education Policies in the Emergency Period for the Spread of Coronavirus Disease (COVID-19). The policy steps was taken by the Minister of Education and Culture include several things, such as the absence of a program for the 2020 National Examination and the entire learning process is carried out from home using distance/online learning methods [5]. From these policies, policies related to the implementation of distance/online learning processes at all levels of education can create new problems and challenges in the world of education. Online learning is a strategy that must be used during a pandemic [6]. The parties must adapt quickly during the COVID-19 pandemic [7]. Students have recently switched from classroom study to e-learning due to the pandemic [8]. There are difficulties experienced by educators in choosing a suitable learning model to be used in the distance learning process [9]. Many countries were forced to discontinue face-to-face training, which resulted in a huge surge in online learning during the pandemic [10]. Online learning during the COVID-19 pandemic is a good step to reduce the spread of COVID-19, and still maintain the continuity of the learning process in educational units.

Internet connection is an important part when online learning is carried out, the learning process is carried out online using various media such as Zoom Meeting, Google Classroom, Google Meet, interactive multimedia, and e-learning systems that require an internet network connection. In addition to the media platforms mentioned above, online learning can use e-learning services. Teaching materials in e-learning should be attractive, interactive, and effective [11]. However, e-learning performance must be the initial component to be built properly. This is because the e-learning platform may be used by multiple students at the same time, which might lead to a drop in e-learning performance [12]. Currently, many educational institutions and agencies have adopted e-learning services to support online learning. One of the causes of the increasing use of e-learning in educational institutions is the availability of various Learning Management System (LMS) software [13]. One of the most popular LMS today is Moodle LMS. Indonesia has 6205 registered sites and is in 6th place in the top 10 of 239 countries that use Moodle [14]. Not surprisingly, many educational institutions, such as universities and shools use Moodle as an LMS to implement online learning. The advantage of Moodle as an option in developing e-learning systems, Moodle source file system can be downloaded freely or is open source [15]. Installing the Moodle system, the source files of Moodle are placed in a directory on the Server [16].

The Web Server's role as a placeholder for the Moodle system becomes very important, all traffic that accesses the Moodle system while doing online learning is handled by the Web Server. Activities when accessing a Web Server by making requests simultaneously can cause the request to overload, and the Web Server to go down [17]. Moodle's response times become slower as the number of concurrent users rises [18]. The condition if the Web Server is down, all data such as the Moodle file system cannot be accessed. Requests from users failed because the workload of the Web Server was too heavy, some incoming requests could not be served [19]. As a result, learning activities carried out using the Moodle LMS have stopped.

In addition to the role of the Web Server which is the point of access for users, an equally important role in the Moodle LMS architecture is the role of the database server. Moodle server and database optimization produces a significant reduction in end-user response time [20]. Database Server is a place to store all learning activities such as teaching materials, student attendance, quiz collections, and other course materials. Database Server also serves as a place to store user information in the Moodle LMS. Learning activities that are accessed by the user from the Web Server, will be forwarded to the database server to request the data requested by the user. E-learning users access the Moodle LMS through the login page, the Web Server provides the login page, if there is a login process, the user data will be retrieved on the Server database and will be forwarded to the user's home page via the Web Server. The database server has a similar way of working with the Web Server, when performing activities to call or save data into the Moodle LMS Database Server simultaneously in very dense network traffic, it can cause overload requests on the database server side. This causes the Web Server to display an error message because the database server is overloaded, so that the connection to the database server fails. While in this state, the user must wait an indefinite amount of time when the request is handled again. This explains that, in the Moodle LMS implementation, the functions of the Web Server and Database Server must always run in tandem, if one fails or experiences an overload request, ongoing learning activities can be stopped at any time, this is certainly very contrary to high availability aspect in service provision. Moodle's strategic deployment as an interactive and collaborative learning platform necessitates good e-learning performance and the appropriate server reconfiguration [21].

The observations of e-learning with Moodle at SMKN 2 Depok reveal that the Moodle system was installed on two server PCs, server 1 and server 2. Server 1 serves as both a Web Server and a Database Server, while the second server functions as a Web Server with a load balance mechanism to help the e-learning Web Server 1 with its workload. Both server machines have the same characteristics, with 32 gigabytes of RAM on each to facilitate the provision of Moodle LMS services, which can be accessible by the entire SMKN 2 Depok network. An interview with Mr. Yunianto Hermawan, a teacher and e-learning administrator at SMKN 2 Depok, showed that e-learning performs well for everyday online learning activities. However, when used during midterm exams, there was an excessive load due to the simultaneous connections of over 1000 students and teachers. The e-learning server 1 is overcrowded on the Web Server and Database Server side, while the e-learning server 2 is overloaded on the Web Server side. CPU data from both e-learning servers reported that all CPU cores were at 100% use, rendering the Moodle LMS inaccessible and the midterm trial exam halted. This occurs because the resources that should be allocated to the Web Server are moved to the Server database, which uses 100% of the CPU resources. The Web Server on e-learning Server 1 lacks the necessary resources to run Web services, and server performance is inadequate. Furthermore, the e-learning Server 2 handles all connection requests to the Web Server, but it turns out that the Web Server on the e-learning Server 2 cannot serve all incoming connections at the same time. Finally, both e-learning servers fail or go into server-down mode. Despite having qualified requirements, the two e-learning servers do not function optimally.

Observations and interviews suggested that SMKN 2 Depok's e-learning performance needs to be optimized to deliver sufficient e-learning services. Tuning the configuration of the Moodle Web Server and LMS Database Server can help improve e-learning performance. By fine-tuning service configurations, system administrators can optimize their e-learning platforms to handle heavy workloads [12], [22]. Several methods that can be used for server optimization are: web balancing method [23]; increasing the number of processes and controlling client handling [24]; and tuning the configuration of several parameters on the Database Server [25], [26]. This article describes the optimization of web servers and database servers when there are multiple large connections at SMK N 2 Depok's E-learning.

O_1 X O_2

O_1 = E-Learning Service Performance Test Results (Before Treatment)
X = Treatment with Web Server and Database Server Optimization
O_2 = E-Learning Service Performance Test Results (After Treatment)

H_{O1} : There is no significant increase in the performance of E-Learning services at SMKN 2 Depok Sleman after the optimization of the Web Server.
H_{a1} : There is a significant increase in the performance of E-Learning services at SMKN 2 Depok Sleman after the optimization of the Web Server.
H_{O2} : There is no significant increase in the performance of E-Learning services at SMKN 2 Depok Sleman after the Database Server optimization treatment.
H_{a2} : There is a significant increase in the performance of E-Learning services at SMKN 2 Depok Sleman after the Database Server optimization treatment.

Figure 1. One-Group Pretest-Posttest Design and Hypotheses in this research

METHODS

The type of research is experimental research, using a pre-experimental design with the type of One-Group Pretest-Posttest Design. One-Group Pretest-Posttest Design [27] can be explained in Figure 1. The research stage was carried out through a pretest test of the performance of the E-Learning service at SMKN 2 Depok Sleman to see the initial conditions of the performance of the E-Learning service (O1), then given treatment in the form of optimizing the Web Server and Database Server (X). After that, a posttest test of the performance of the E-Learning service was carried out to find out the results of the E-Learning (O2) service performance test. Then, the data from the pretest and posttest were compared with data analysis to see the differences that resulted from the treatment activities.

Hypothesis testing in this study can be formulated as below. The population is a generalization area consisting of objects and subjects with certain characteristics and qualities so that researchers can study them, then draw conclusions [27]. Then the population used as a source of data in this study are users or users contained in the E-Learning service as many as 2180 active users. The sample in this study was determined by measuring the sample using the slovin formula which is described as in formula 1.

$$S = \frac{N}{1+N.e^2} \quad \text{...} \quad (1)$$

Information: S = Sampel, N = Population, e = Desired degree of accuracy or critical value

$$S = \frac{2180}{1+1280.0.05^2} = \frac{2180}{6,45} = 337,984$$

From the results of the sample calculation, the number of samples in this study was 337,984 and rounded up to 338 samples. The sample represents the characteristics of the population, namely 338 samples are connections built by users who can access E-Learning services. The method used in analyzing the data is a comparative or comparison method, using the T test technique. The T difference test is used to compare the performance of the E-Learning Moodle service between before treatment and after being given optimization treatment. After that, the results of data analysis can be concluded to test the research hypotheses that have been described previously [28]. The method used in analyzing the data is a comparative or comparison method, using the T test technique. The T difference test is used to compare the performance of the E-Learning Moodle service between before treatment and after being given optimization treatment. After that, the results of data analysis can be concluded to test the research hypotheses that have been described previously [28].

RESULT AND DISCUSSION

This study aims to optimize the performance of the Web Server and Moodle E-Learning Database Server at SMKN 2 Depok when given a large connection at the same time. To optimize the performance of the Web Server and Database Server, optimization treatment is carried out with tune ups on the E-Learning Server. Differences in the performance of a Web Server and Database Server E-Learning, before and after optimization treatment, Web Server and Database Server are tested by testing the performance load through Web Server performance variables which include, Response Time and Throughput. Performance variables for Database Server can be seen through Transaction Per Second (TPS) and Response Time variables..

Interview Result

The interview was conducted with Mr. Yunianto Hermawan as the person in charge of the e-learning Moodle service at SMKN 2 Depok. The study's findings include the utilization of e-learning servers and their limitations. The e-learning server is used to support the distance learning process during the COVID-19 pandemic. e-learning services are used and collaborated with several other platforms such as Google Classroom, Google Meet, and other learning platforms that support distance learning. E-Learning services are also used to carry out examinations such as daily tests of theory and practice which can be done through e-learning. Then the e-learning service is also used in the implementation of the Mid-Semester Assessment and End of Year Assessment. The daily learning process, the E-Learning Server has no problems such as the service experiencing downs. However, on March 8, 2021, during PTS activities, the E-Learning service was very slow to be accessed by more than 1000 students who participated in PTS activities. As a result, after feeling the service becomes slow to access, a few moments later an error message appears indicating that the service is not available. Finally, PTS activities were stopped for a few minutes and can still be continued even though the service feels slow.

ISSN 2580-6424 (printed) | ISSN 2477-2399 (online)

Observation Result

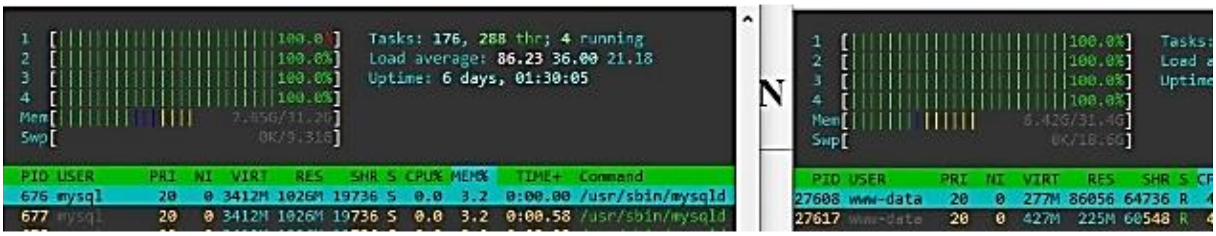

Figure 2. Total load CPU at 2 Server E-Learning

In addition to conducting interviews, to see whether the server condition is good or bad, it is done by observing the resource utilization used by the E-Learning Server during PTS activities. On the first day of PTS activities, where the E-Learning Server was accessed by more than 1000 Teachers and Students, the E-Learning service was overloaded on the CPU side with a total CPU load reaching 100%. For more details, the results of observations on the total CPU load can be seen in Figure 2. When the total CPU load is at 100%, the E-Learning Server experiences an access failure on the Database Server side where the browser page displays an error message that the E-Learning service cannot be accessed for a while due to an error while connecting to the database. The error message is shown in Figure 3. After the error message appears, downtime occurs on the E-Learning Server, PTS activities must be temporarily stopped. PTS activities are resumed after waiting for the E-Learning Server to be accessed again.

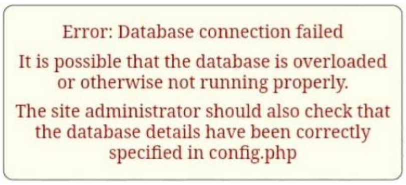

Figure 3. Error message at browser

E-learning server performance testing aims to see performance based on web server performance variables, include response time variables, and throughput variables. Then to see the performance of database server performance, it can be seen through the response time, and transaction per second (TPS) variables [29]. Tests are carried out before and after the e-learning server optimization treatment process takes place.

E-learning Web Server Testing Result

Web server testing with Apache Benchmark instrument to test web server performance based on response time and throughput variables. The test runs for 10 times with each time the web server test is given a load based on the number of connections starting from 500, 1,000, 1,500, 2,000, 2,500, 3,000, 3,500, 4,000, 4,500, and 5,000 the number of connections with 338 user connections that can access the web server. The results of testing the performance of Web Server 1 and Web Server 2 on the response time and throughput variables before and after optimization can be seen in Table 1.

Table 1. Testing Result Performance of Web Server 1 and Web Server 2

Web Server 1				
Total Connection	Response Time (Ms) Before	Response Time (Ms) After	Throughput (KB/s) Before	Throughput (KB/s) After
500	4.285	1.022	158.15	663
1000	4.178	0.889	162.22	762
1500	3.263	0.772	207.68	878.3
2000	2.495	0.865	271.59	783.49
2500	1.99	0.778	340.55	860.13
3000	1.668	0.768	406.27	882.07
3500	1.44	0.803	470.61	843.99
4000	1.281	0.732	528.98	925.99
4500	0.868	0.697	780.73	973.73
5000	0.844	0.715	803.27	948.42

Web Server 2				
Total Connection	Response Time (Ms) Before	Response Time (Ms) After	Throughput (KB/s) Before	Throughput (KB/s) After
500	4.484	1.187	151.14	570.98
1000	3.076	0.804	220.3	843.26
1500	2.738	0.739	247.49	916.83
2000	4.077	0.923	166.23	733.97
2500	2.441	0.814	277.81	830.16
3000	1.671	0.703	405.89	965.83
3500	1.011	0.761	671.21	891.71
4000	1.263	0.943	536.59	718.35
4500	1.486	0.974	456.15	696.15
5000	1.203	1.003	563.55	675.86

ISSN 2580-6424 (printed) | ISSN 2477-2399 (online)

The performance data of Web Server 1 and Web Server 2 E-Learning Moodle at SMKN 2 Depok can be visualized using diagrams. The form of Web Server 1 and Web Server 2 performance visualization with a line chart for Response Time performance in Figure 4 and a bar chart for Throughput performance in Figure 5.

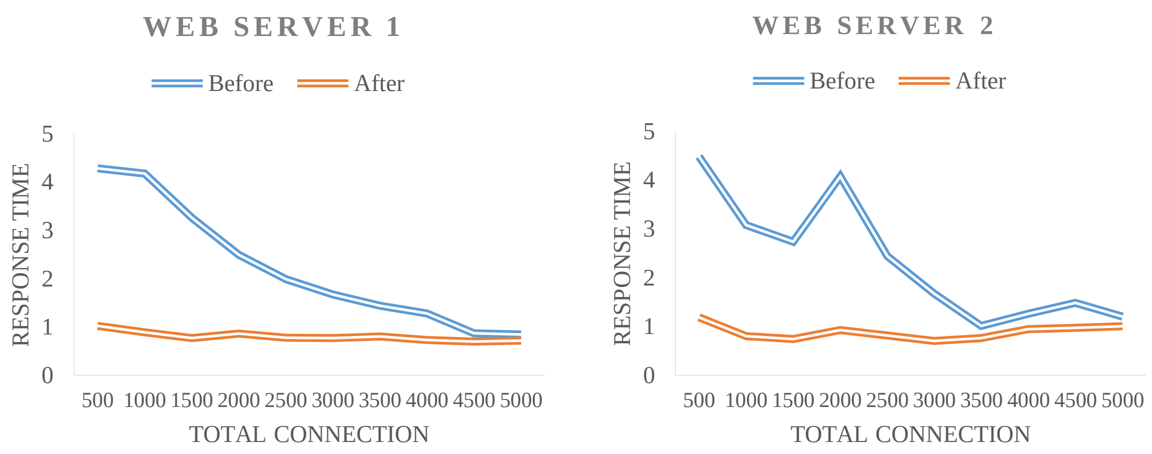

Figure 4. Web Server 1 and Web Server 2 Response Time Performance Data Visualization

Based on the line diagram in Figure 4, after the optimization process, Web Server 1 is more stable in responding to requests requested by the Client, both on small connections to the largest connection on 5000 connections. Meanwhile, the response time performance of Web Server 1 before optimization tends to be unstable when given a small to medium connection, even though when the number of requests reaches 4500, and 5000 the response time value is under 1 second, namely, 0.868 ms and 0.844 ms. However, after the optimization process, the response time performance on the number of requests was 4500, and 5000 was still better than before optimization, with values of 0.697 ms and 0.715 ms. The response time data for Web Server 2 is almost the same as Web Server 1. Prior to optimization, the response time performance tends to be unstable and the Web Server takes more time to handle client requests up to a maximum of 4.8 second. However, after optimization, the response time performance of Web Server 2 reduces the time in handling client requests by a maximum of 1.18 seconds and from the diagram above, the performance is more stable with the average response time to the client having a time of 0.8 seconds both at small connections to large connections.

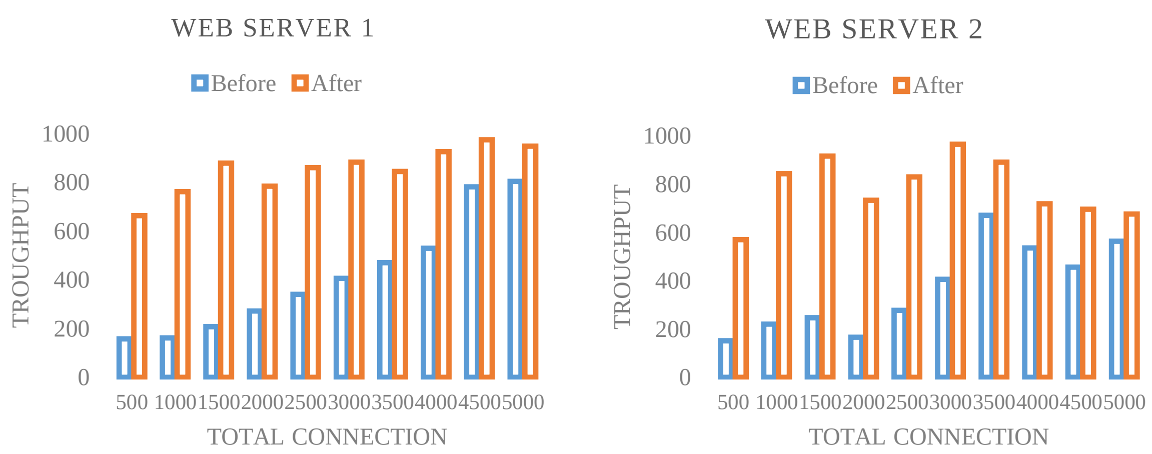

Figure 5. Web Server 1 and Web Server 2 Throughput Performance Data Visualization

Based on the bar chart in Figure 5, the throughput performance on Web Server 1 and Web Server 2 are better after optimization. The throughput performance in Web Server 1 before optimization always shows an increase, but the throughput performance is not better than after optimization. The throughput performance on Web Server 2 is better after optimization. The throughput performance before optimization is very difficult to get a throughput value above 500 KB/sec, because the average value is 369,636 KB/sec. Meanwhile, after the optimization process, the average throughput performance value was 784.31 KB/Sec.

Performance Improvement of Moodle E-Learning Web Server Performance The results of the Moodle E-Learning Web Server performance data analysis using a different test showed a significant difference in the response time and throughput performance variables between conditions before and after optimization. From the results that show the difference between conditions before and after receiving optimization treatment, it can be concluded that after the Web Server is given optimization treatment it can improve performance. This is in line with the data visualization displayed on the data which shows that after the optimization of the response time performance graph on Web Server 1 and Web Server 2 E-Learning Moodle becomes more stable and sloping in responding to client requests when the number of requests is small to large requests. Based on the throughput performance graph, the Client can send a better amount of throughput after optimization than before optimization. These results are also in line with Arman's research that by optimizing with Tuning Server can improve Web Server performance [30].

E-learning Database Server Testing Result

Database Server testing is done with the Sysbench instrument to test the performance of the Database Server based on the Response Time and Transaction Per Second variables [14]. The test takes place 10 times with each time the Database Server test is given a load based on the number of data records starting from 50,000, 100,000, 150,000, 200,000, 250,000, 300,000, 350,000, 400,000, 450,000, and 500,000 the number of data records in the database with user connections that can access Database Servers numbered 338. The Database Server testing phase is carried out through 2 modes, namely Simple Mode and Complex Mode. Testing with Simple Mode only tests the performance of the Database Server by running a read query only. Meanwhile, the Complex Mode test does not only test the performance of the Database Server by running read queries only, but also by using a combination of queries such as, read, update, and delete. The results of testing the performance of Database Server (Simple Mode and Complex Mode) on the response time and throughput variables before and after optimization can be seen in Table 2.

Table 2. Testing Result Performance of Database Server (Simple Mode and Complex Mode)

Simple Mode					Complex Mode				
Total Data	Response Time		TPS		Total Data	Response Time		TPS	
	Before	After	Before	After		Before	After	Before	After
50.000	150.29	94.1	3579.95	3839.62	50.000	211.27	159.5	1598.55	2115.66
100.000	170.48	92.42	3316.24	3406.08	100.000	213.79	158.53	1579.59	2129.69
150.000	196.89	118.92	2962.06	3280.96	150.000	217.28	158.66	1553.89	2127.7
200.000	223.34	158.63	2551.28	2777.59	200.000	211.37	158.17	1597.39	2134.85
250.000	248.83	196.89	2282.67	2380.62	250.000	209.51	155.28	1612.1	2173.62
300.000	272.27	215.44	2085.63	2173.05	300.000	206.26	154.47	1636.96	2185.3
350.000	287.38	211.6	1964.91	2249.69	350.000	206.52	152.62	1634.9	2212.18
400.000	303.33	235.74	1849.38	2170.16	400.000	201.26	151.35	1678.59	2230.05
450.000	308.84	244.38	1827.78	2051.71	450.000	200.02	149.54	1688.19	2257.47
500.000	308.84	267.41	1805.96	2009.29	500.000	197.49	149.06	1709.95	2265.14

The performance data of the Moodle E-Learning Database Server at SMKN 2 Depok can be visualized using a diagram. The form of visualization of Database Server performance with a line chart for Response Time performance can be seen in Figure 6 and a bar chart for TPS performance in Figure 7. Based on the simple mode database response time data visualization, every time the number of data records increases, the response time will also improve before and after optimization is carried out. However, after the optimization process, the response time can be reduced so that the Database Server

ISSN 2580-6424 (printed) | ISSN 2477-2399 (online)

can respond to requests faster. Before optimization, for the number of records of 500,000 data it took as much as 308 ms, and after optimization it was suppressed to 267 ms. When testing complex mode, the response time performance before optimization was stable at more than 200 ms, while after optimization the response time number could be reduced and resulted in an average response time of 154.7 ms.

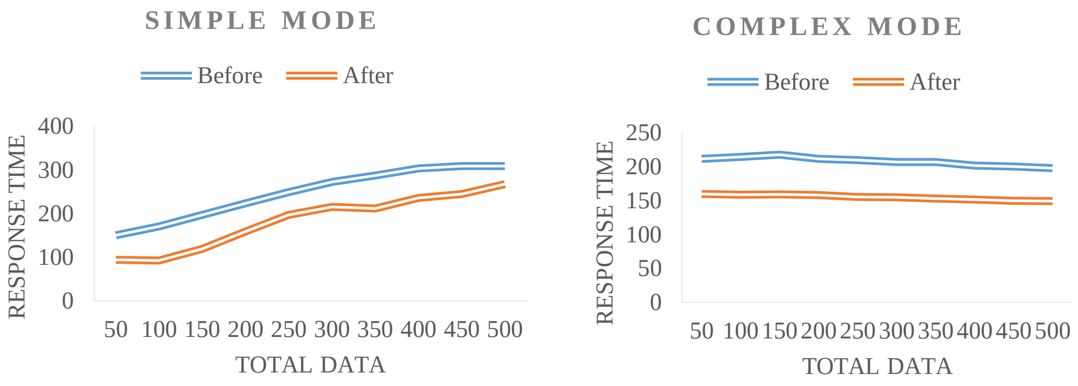

Figure 6. Database Server Response Time Performance Data Visualization

Based on Figure 7, the performance of TPS on the Database Server during simple mode testing also shows a difference between the conditions before optimization and after optimization. Transactions that occur every second on the database server after optimization, when the largest number of data records is 500,000 data, the average number of TPS generated is still in 2009,29. Meanwhile, prior to optimization, when the number of data records was in the range of 350,000 – 500,000, the average TPS was already below 2000. The performance of the TPS Database Server during complex mode testing is better after optimization. It can be seen that the TPS performance before optimization was carried out could not reach the number of transactions above 2000 TPS. Meanwhile, after the Database Server optimization process can carry out transactions of more than 2000 TPS.

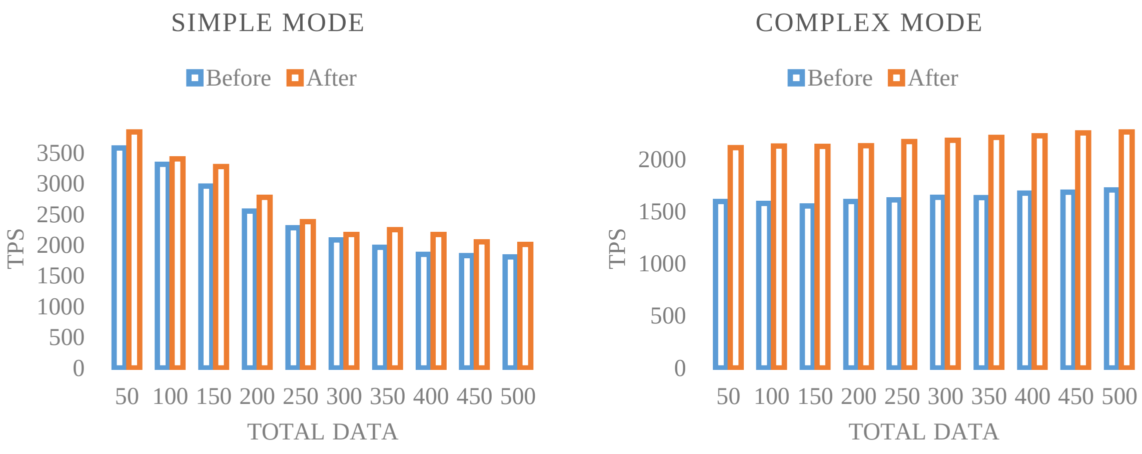

Figure 7. Database Server TPS Performance Data Visualization

The performance of the Moodle E-Learning Database Server, the results of the different test analysis show that there is a significant difference between the conditions before and after being given optimization treatment, both when tested with Simple Mode and using Complex Mode testing. Because there is a difference in performance shown in the response time and TPS Database Server variables, this indicates that there is an increase in the response time and TPS Database Server performance after being given optimization treatment. Presentation of Database Server performance data, Database Server's ability to respond to client requests in response time performance becomes better after optimization. The same thing can be seen in TPS performance, transactions that occur every second have increased after optimization compared to before optimization [31].

The results of the T-Test Analysis of Paired Samples

The data from the performance testing of the Web Server and Database Server that has been obtained, is carried out with different tests in order to know the difference in performance before and after optimization treatment is carried out on the Moodle Web Server, and the Moodle Database Server which is applied or generalized to the entire population. T-test analysis of the performance of the Web Server E-Learning Moodle, is used to see a difference before and after the optimization treatment can be seen from the probability or significance value on the T test. If the probability value (sig) < 0.05, then there is a significant difference in the performance variable. Web Servers. Conversely, if the probability value (sig) > 0.05, then there is no significant difference in the Web Server performance variable.

Table 3. Results of T Test Analysis on Web Server

Web Server 1				Web Server 2			
Variabel	Std. Deviation	T Value	Sig.	Variabel	Std. Deviation	T Value	Sig.
Response time	1.201505	3.756	.005	Response time	1.188558	3.884	.004
Throughput	166.64296	-8.333	.000	Throughput	206.99922	-6.335	.000

Based on Table 3, the response time performance before and after optimization treatment has a significance value of 0.005 < 0.05, it can be concluded that there is a significant difference in the response time performance of Web Server 1 between conditions before and after optimization. The throughput performance has a significance value of 0.000 < 0.005, and it can be concluded that there is a significant difference in the throughput performance of Web Server 1 between conditions before and after optimization. The response time performance before and after optimization treatment has a significance value of 0.004 < 0.05, there is a significant difference in the response time performance of Web Server 2 between conditions before and after optimization. The throughput performance has a significance value of 0.000 < 0.005, and it can be concluded that there is a significant difference in the throughput performance of Web Server 2. From the results of the T Difference Test for the performance of the Moodle E-Learning Web Server, the Web Server performance data for the response time and throughput variables has a P Value (Sig.) < 0.05. Therefore, hypothesis testing was found that Ho1 was rejected and Ha1 was not rejected. This indicates that there is a significant increase in the performance of the E-Learning service at SMKN 2 Depok Sleman after the Web Server optimization treatment.

Table 4. Results of T Test Analysis on Database Server

Simple Mode				Complex Mode			
Variabel	Std. Deviation	T Value	Sig.	Variabel	Std. Deviation	T Value	Sig.
Response time	12.06432	16.643	.000	Response time	2.94834	56.587	.000
TPS	91.10308	-7.334	.000	TPS	17.99302	-97.393	.000

Based on Table 4, the response time performance before and after the optimization treatment has a significance value of 0.000 < 0.05, it can be concluded that there is a significant difference in the response time performance of the Simple Mode Database Server between the conditions before and after optimization. TPS performance has a significance value of 0.000 < 0.005, and it can be concluded that there is a significant difference in TPS Database Server Simple Mode performance between conditions before and after optimization. The response time performance has a significance value of 0.000 < 0.05, there is a significant difference in the response time performance of the Complex Mode Database Server. TPS performance has a significance value of 0.000 < 0.005, it can be concluded that there is a significant difference in TPS Database Server Complex Mode performance.

Moodle's E-Learning Service Optimization Process

Based on the results of the analysis of Moodle's E-Learning service performance data on the Web Server and Database Server side, the Web Server and E-Learning performance increased after optimization. During the process, optimization of the Moodle E-Learning service is carried out by tuning the Web Server and Database Server configurations according to the relevant rules and theories in optimizing the Moodle E-Learning Web Server and Database Server. The process of optimizing the Web Server E-Learning is divided into 2 parts by increasing the number of processes that can be handled or increase number of processes and by controlling the flow of incoming connections to the web server from the client or can be called controlling client handling.

ISSN 2580-6424 (printed) | ISSN 2477-2399 (online)

To increase the number of processes that can be accepted by the Web Server, there are several parameters that can be optimized by tuning. To measure the quality of performance from the optimization results of Web Server E-Learning can be measured through the response time and throughput variables. When the initial test was carried out, the E-Learning Web Server of SMKN 2 Depok Sleman had unstable performance in serving client requests or response times, and the amount of throughput which only had an average value of less than 500 KB/second. Then, optimization activities were also carried out on the Moodle LMS Database Server by using the InnoDB storage engine, increasing the packet size, activating thread concurrency and thread cache, then activating the query cache, and determining the size of the buffer pool. To see the performance quality of the E-Learning Database Server, it can be measured through the response time and Transaction Per Second (TPS) variables. Initial testing on the E-Learning Database Server at SMKN 2 Depok Sleman, showed that the response time performance to client requests took an average response time of more than 200 ms, and unstable TPS performance below 2000 TPS.

The following are important parameters in the increasing number of process: (1) Max Clients/ Max Request Workers - this parameter will determine the maximum number of clients that can connect to the Apache Web Server child process; (2) MinSpareServers parameter can be optimized and calculated with 25% of Max Clients value; (3) MaxSpareServers parameter is optimized by calculating the MinSpareServers parameter value x 2, and (4) StartServers parameter is optimized by equalizing the value of the MinSpareServers parameter. In addition to increasing the number of processes that the Web Server can handle. Optimization is done by adjusting the connection flow. The following parameters that can be optimized: (1) Timeout parameter is set smaller than the default condition of 300 to be smaller between 60 – 100 to prevent DoS attacks; (2) MaxKeepAliveRequest parameter allows how many connections can be persistently connected on a TCP connection. The recommended value for this parameter is in the range of 250 – 500 requests; (3) MaxKeepAliveTimeout - Sets a timeout on the connection to stay connected while waiting for the same client to send the next request. Set a value for this parameter in the range of 3 – 5 seconds.

Approx Max Con. Users = Total RAM x 50 .... (2)

Thread Size and Conn = Number of CPU x 2 .... (3)

Thread Cache Hit =100 - (((Threads_created)/Connections)x 100) .... (4)

Database Server optimization process by tuning the configuration of several parameters on the Database Server. The process of optimizing the Moodle E-Learning Database Server can be done in the following ways: (1) Counting Max Connections - The max connections parameter determines how many connections can access the Database Server at the same time. Calculate the value of max connections using the formula 2 [25]; (2) Determine Storage Engine - MariaDB Database Server has several options in using the storage engine. Recommendation from MariaDB, prefer to use InnoDB as storage engine; (3) Determining the size of Buffer Pool - The use of a buffer pool is useful for storing data and indexing into RAM, not on the main storage device or hard disk. To determine how large the buffer pool is used, there should be at least 70 – 80% of RAM usage; (4) Enabling Thread Concurrency and Thread Cache - The number of process thread sizes used by the Database Server and determines the concurrency level of the thread processes using the formula 3; In addition, specifying the cache thread size helps to increase the high volume of connections per second on the Database Server. Calculate the thread cache size using the formula 4 [26]; (5) Increase Packet Size - The default allowed packets to be sent to the Database Server is 16 MB. However, the need for Moodle E-Learning that requires resources such as learning modules, quizzes, learning videos, requires adjustments to the Server hardware specifications; and (6) Activated Query Cache - The query cache is activated in order to speed up the performance of the same query and the query can be reused within a certain time [31]. However, the use of query caches can cause bottlenecks in the Database Server and this feature should be disabled and look for other ways to speed up querying and indexing such as adding replication [26]. As for another opinion from James (2018), it is better if the query hit rate is less than 50% percentage then disable the query cache, but if it is more than 50% query hit rate then it can be activated [32].

Based on this explanation, this research proves that by optimizing the E-Learning Server on the Web Server and E-Learning Database Server side according to the relevant instructions and theories. The performance of the Moodle E-Learning service at SMKN 2 Depok Sleman can be improved and work more optimally to reduce response time performance and increase throughput on the Web Server, as well as suppress response time performance and increase the number of TPS on the Database Server. Regarding server improvement techniques/methods, they need to be adapted to the problems and needs of each e-learning at certain institutions. Optimizing server tuning should be the primary concern for school-based e-learning developers. Another thing that perhaps needs to be considered for future e-learning development is integrating Problem Based Learning in e-learning [33]. However, the attraction of e-learning in terms of increasing the essence of learning outcomes that students must acquire is as important. Educational institutions must offer an engaging e-learning environment [34]. This is based on the finding that students do not find online learning more interesting than traditional learning [35]. E-learning facilitates edutainment [13]. As a result, after assuring server optimization, the development of e-learning in education must also ensure the attractiveness of e-learning to support students' achievement of learning goals. This research is still limited to efforts to optimize web server and database server performance. Important things that educational institutions need to consider when developing e-learning are the effectiveness and efficiency of the server and the ability of e-learning to provide only interesting but interesting learning material for students.

CONCLUSION

Moodle is an e-learning platform that is widely used in Indonesia, including at SMKN 2 Depok Sleman. There are problems using e-learning in this school. There is overload due to multiple connections at once when used during midterm exams. The experimental research carried out in this research was to look at the performance of e-learning between before and after optimization of the web server and database server was carried out. The results show that: (1) The performance of the Moodle E-Learning Web Server can be optimized by optimizing the Web Server configuration tuning with increased Number of Process, as well as by Controlling Client Handling. There is a significant improvement in the quality of response time performance and Web Server E-Learning throughput; and (2) The performance of the Moodle E-Learning Database Server can be optimized by optimizing the Database Server configuration tuning such as using the InnoDB storage engine, increasing the packet size, enabling thread concurrency and thread cache, enabling query cache, and determining the buffer pool size. There is a significant improvement in the quality of response time and TPS performance from the E-Learning Database Server. Both the web server and the database server show a significant increase in performance between before and after optimization. Optimization is carried out by increasing the number of processes and controlling client handling on the web server; and tuning the configuration of several parameters on the Database Server. By improving performance after optimization, it can reduce the problem of using e-learning at one time with multiple connections in SMKN 2 Depok Sleman e-learning. In this way, learning activities (simultaneous exams) can be carried out well. Increasing e-learning performance needs to be accompanied by increasing e-learning content, both in terms of quality and attractiveness. These results indicate that educational institutions need to conduct a needs analysis for both infrastructure and e-learning content that is appropriate to the school's problems and needs. Optimizing e-learning server settings is something that needs to be considered first to support learning effectiveness.

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