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The Impact of Integrating Internet of Things (IoT) Technology in Learning on Class Management Efficiency

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ABSTRACT

Internet of Things (IoT) technology is something that is equipped with sensors and software so that it can send data over a network without human interaction. As a result, the Internet of Things can improve connectivity by connecting many devices via the internet, facilitating human interaction with machines. This research was conducted with the aim of increasing efficiency, reliability and innovation in the teaching and learning process. By using IoT, this research focuses on developing interactive and personalized learning media to increase students' understanding of technology. In addition, this research aims to improve teachers' abilities in using information technology to help students learn to use it. In conducting this research, researchers used quantitative methods in carrying out the research. The data obtained by the researcher was obtained through distributing questionnaires presented by the researcher via a goggle from application. The distribution of this questionnaire is carried out by researchers online, and then the results of the distribution of this questionnaire will be processed using an SPSS application. From this research, researchers can conclude that the integration of Internet of Things (IoT) technology can increase classroom management efficiency. With the help of the Internet of Things (IoT), teachers can monitor and manage classes more efficiently and intelligently by collecting data such as student activity, room temperature, and other information. Thus, IoT allows teachers to make smarter and strategic decisions about classroom management. Based on the results of this research, the impact of integrating IoT technology can provide benefits for teachers and students. Developing digital skills is one of the benefits of integrating IoT technology. By learning how to use Internet of Things technology in learning, teachers can improve their digital skills and increase their ability to use technology to improve the efficiency and quality of education.

Keywords: *Classroom, IoT, Learning*

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INTRODUCTION

Quality and capable human resources are very dependent on education. Consequently, every country is responsible for providing adequate education to young people to protect their future (Colonna, 2023). Technology is currently developing rapidly and is very important for education. Through various innovative applications and systems, technology has assisted learning (Melchiorre et al., 2022). One very important and strategic sector in a country's development is education. Information and communication technology (ICT) is very important to improve the quality of education in the current era of globalization (Severo et al., 2018). Internet of Things (IoT) is a technology that allows objects or electronic devices to connect and communicate with each other.

Teachers have a very big contribution to the success of learning in school. Teachers play a very important role in helping students develop to achieve their best life goals (Tsai et al., 2020). Teachers carry out two main tasks in the classroom, namely teaching and learning and managing the class. Basically, teaching activities are the process of managing and organizing the learning environment around students (Dewaele & Dewaele, 2020). All elements of teaching, including objectives, learning materials, learning activities, methods, tools, and resources, as well as evaluation, must be carried out in the best way to achieve the teaching objectives that have been established before class begins. Therefore, classroom management includes classroom settings, physical facilities, and procedures, as well as management of various aspects of learning (Sandilos et al., 2020). One of the goals of classroom management activities is to create and maintain a good classroom atmosphere. to ensure that the teaching and learning process takes place well and efficiently.

Internet of Things (IoT) technology has become a revolutionary innovation in various areas of life, including education, especially in the digital era which continues to develop rapidly today (Seufert et al., 2022). Management of school facilities and infrastructure must be continuously improved to create an ideal learning environment amidst demands for efficiency and technological progress (Tai & Brandt, 2018). The rapid development of the internet of things (IoT) has opened new avenues for optimizing the management of educational facilities and infrastructure (Wong & Moorhouse, 2021). By connecting various devices and sensors, IoT enables today's educational institutions to utilize data in real time, increase operational efficiency, and increase the security and comfort of the teaching and learning environment.

In the modern era, teachers must continue to learn about technology to provide better teaching and a modern and conducive learning environment to students. By

understanding and mastering this technology, educational institutions can be better prepared to face global competition and meet educational needs that continue to develop (Lauermann & Ten Hagen, 2021). Internet of Things (IoT) technology is a technology that connects various physical devices such as sensors, electronic devices, vehicles, etc. to the internet network (Fauth et al., 2020). According to the statement, IoT can enable devices to collect, send and receive data automatically over the network, enabling a smarter and safer environment.

IoT has not been widely used in education in Indonesia. Most schools still use traditional learning, namely blackboards and books (Kulurkar et al., 2023). This can have an impact on the efficiency and effectiveness of learning, making students bored and disinterested in the process. As a result, more innovative and creative learning systems must be created to improve the quality and effectiveness of learning in schools (Goap et al., 2018). Therefore, teaching staff and all educational institutions in Indonesia strive to continue to develop all the potential that exists for changes in the learning process (Lohan et al., 2018). Having new learning methods when used when studying will have a good impact on future learning outcomes, as well as being able to use technology to be integrated into the learning process.

Technological integrity Internet of Things is a subcategory of technology that uses the internet to support education. Students can easily access teaching materials and other resources from anywhere using the IoT system, and using IoT technology can also collect and share data via other devices (Srinivasu et al., 2021). This system can also be used by educators to improve the teaching and learning process. Smart devices such as projectors, cameras, and others can be used in the classroom environment during the learning process (W. Wang et al., 2019). In the field of education, using Internet of Things (IoT) technology, which is useful for helping educational institutions and changing learning systems into m-learning (Mobile Learning) and e-learning (Electronic Learning). This starts with various devices such as tablets, e-book readers, gadgets, and social media.

Students can get information and knowledge with the help of devices connected directly to the internet. One of the goals of creating a learning system with the integration of IoT technology is to improve the quality of learning and convenience for students (Akhigbe et al., 2021). If a student cannot follow lessons quickly or faces obstacles to attending class, they will be considered behind in their lessons (Suwarno et al., 2021). However, if the learning system implements IoT, students will find it easier to learn lessons. IoT will be able to create a responsive and interactive networking environment in the learning process that is in line with current technological advances.

The type of method used in this research is a quantitative method. This method is used so that the final results of the data processing can be known clearly and precisely. Based on the explanation of the research above, researchers assume that the impact of

integrating Internet of Things (IoT) technology in learning on classroom management efficiency has a very large role or a very effective influence in the field of education. Because of this IoT technology, it can provide high security and efficiency in classroom management. And researchers also have a hope that future researchers will research the impact of integrating Internet of Things (IoT) technology in learning on classroom management efficiency and research it again in depth and develop research to get maximum results.

RESEARCH METHODOLOGY

Research Design

The method that has been used in this study, namely quantitative method, where to obtain research data conducted by researchers, researchers distributed questionnaires online through the Google from application. From the results of obtaining the data, it will be combined and put together. Furthermore, the data will certainly be processed using the SPSS application to compare the results of the respondents' responses. By processing the data results using the SPSS application, researchers can see and compare the data that researchers have submitted regarding the Impact of the Integration of Internet Of Things (IoT) Technology in Learning on the Efficiency of Classroom Management.

Research Procedure

In this study, there are several stages or procedures that have been determined. When researchers want to collect the results of research data, first of all, researchers make a questionnaire that is distributed online, so that researchers can choose samples randomly. The questionnaire contains 10 questions each related to the impact of the integration of Internet of Things (IoT) technology in learning on the efficiency of classroom management. The purpose of the researcher to investigate this research is so that the researcher can collect, analyse, and provide an understanding of the data that has been collected. That way, researchers will find it easier to examine the data being studied regarding the Impact of the Integration of Internet Of Things (IoT) Technology in Learning on the Efficiency of Classroom Management.

Research Subjects

In researching the Impact of the Integration of Internet of Things (IoT) Technology in Learning on the Efficiency of Classroom Management, researchers certainly determine the subject for their research. In this study, the subjects in this study were addressed to teachers and students from various educational institutions. As for

before the distribution of the questionnaire was carried out by the researcher, the researcher asked the respondents first to be able to take the time to fill out the questionnaire that the researcher would distribute. The questionnaire contains 10 questions each about the impact of the integration of Internet of Things (IoT) technology in learning on the efficiency of classroom management.

Research Ethics

In writing an article entitled The Impact of the Integration of Internet Of Things (IoT) Technology in Learning on the Efficiency of Classroom Management, it is very important for researchers to consider ethical values or ethics in conducting research. Researchers really maintain a balance in conducting research in order to remain consistent and careful in carrying out the research being researched. In this study, researchers also uphold a commitment they have made, by presenting accurate data related to their research. In addition, researchers also try as much as possible to be able to avoid negative things such as plagiarism in their research.

Data Collection and Analysis Techniques

The data collection technique carried out by the researcher aims to identify the relationship and become a benchmark for the object material of the research study. In this study, researchers conducted data collection techniques using quantitative methods and by using software in the form of a T-test. For that, researchers need to present data in the form of tables and diagrams that will be made into averages or percentages. Furthermore, researchers also do not forget to ensure that the results of the answers given by respondents are very accurate and reliable by testing first. Therefore, researchers must be very careful in collecting processed data.

Table 1. Categories of Impact of Internet Of Things (IoT) Technology Integration

No	Subjek Penelitian	Jumlah Peserta	Persentase (%)
1	Guru	15	60%
2	Siswa	15	65%

Figure 1. Data Collection and Analysis Flow

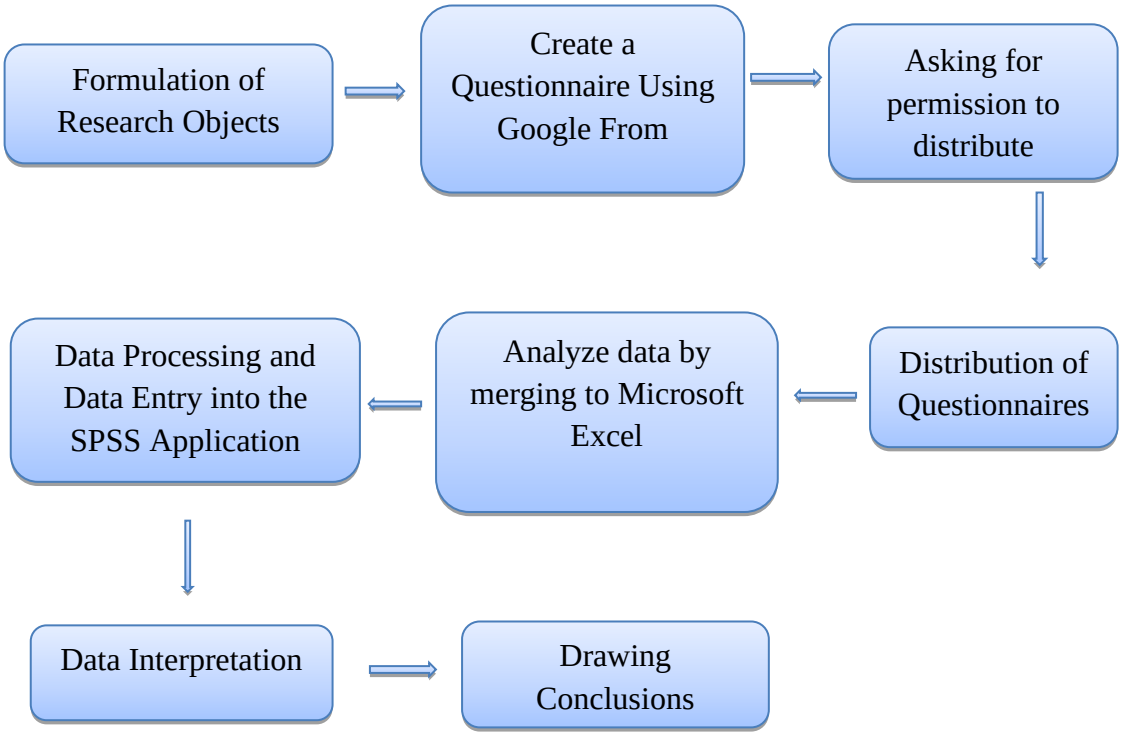

Figure 1 above shows how researchers collect and analyse research data. The results of data acquisition come from respondents‘ answers to researchers’ questions. Furthermore, in quantitative research methods, researchers will also test again using the T-test which will be used to enter research data into the SPPS application. The number of questions asked by the researcher totalled 20 questions, where each question was divided into ten questions with different questions. Only after the questionnaire is distributed, the researcher can formulate and draw conclusions from the research of the research object.

RESULT AND DISCUSSION

The Impact of Internet Of Things (Iot) Technology Integration in Learning

The impact of Internet of Things (IoT) technology on learning is vast and varied. In the context of education, the Internet of Things enables the acquisition of real-time data on each student's behaviour and progress, allowing teachers to monitor student progress and identify students who need more attention. As such, the Internet of Things increases time efficiency between teachers and students, and enables more personalised

learning. In addition, the Internet of Things enables the use of smart sensors and connected devices to create a more interactive and effective learning experience. In addition, IoT allows sensors to analyse the data collected by the sensors, so teachers can create learning strategies that match students' level of understanding and learning speed. Thus, the Internet of Things helps to create a more relevant and significant learning experience for each student.

Table 2. Recap of Percentage Results of Teacher Respondents' Answers

No.	Question	Strongly Agree	Agree	Somewhat Agree	Disagree
1	IoT enables more effective classroom management by integrating various devices and systems, such as temperature control systems and humidity control systems, thereby increasing classroom management efficiency	30%	50%	15%	5%
2	IoT allows students to be more active in the learning process by integrating various devices and systems, such as tablets and projectors, thereby increasing student involvement in the learning process	30%	40%	20%	10%
3	IoT enriches learning with the use of augmented reality (AR) and virtual reality (VR), students can explore subjects such as human anatomy or planetary rotation with three-dimensional images, increasing their grasp and understanding of complex subject matter	33%	57%	5%	5%
4	IoT enables more efficient energy use by integrating various devices and systems, such as temperature	45%	50%	3%	2%

	control systems and humidity control systems, thereby saving operational costs				
5	IoT allows teachers to be more active in the learning process by integrating various devices and systems, such as tablets and projectors, thereby increasing teacher involvement in the learning process	60%	30%	8%	2%
6	IoT enables more effective management of school facilities by integrating various devices and systems, such as water systems and preservation systems, thereby improving the quality of school facilities	30%	45%	20%	5%
7	IoT enables more effective classroom management by integrating various devices and systems, such as temperature control systems and humidity control systems, thereby increasing classroom management efficiency	25%	65%	10%	0%
8	IoT allows students to be more active in the learning process by integrating various devices and systems, such as tablets and projectors, thereby increasing student involvement in the learning process	50%	45%	5%	0%
9	IoT devices can detect damage or malfunctions to classroom equipment before they occur, helping prevent learning disruptions and saving costs	20%	70%	5%	5%

10	IoT can automate administrative tasks such as attendance, assessments, and data recapitulation, freeing up teacher time to focus on interactions with students	55%	35%	7%	3%

Table 2 above shows the distribution of questionnaires that have been conducted by researchers. This questionnaire contains ten questions about the impact of the integration of internet of things (iot) technology in learning on the efficiency of classroom management on teachers. In addition, during the distribution of the questionnaire, the researcher has percentageed each response result from the respondents. Therefore, respondents can choose to answer the researcher's questions by providing options such as strongly agree, agree, disagree, or disagree. And it can also be seen from the first question asked by researchers regarding IoT allows more effective classroom management with the integration of various devices and systems, such as temperature control systems and humidity control systems, thereby increasing the efficiency of classroom management, getting the highest score of 50% agree option.

The second question about IoT allows students to be more active in the learning process with the integration of various devices and systems, such as tablets and projectors, thus increasing student involvement in the learning process, received a percentage of 20% disagree. The third question about IoT enriching learning with the use of augmented reality (AR) and virtual reality (VR), students can explore subjects such as human anatomy or planetary rotation with three-dimensional images, improving their capture and understanding of complex subject matter, scored 57% agree. The fourth question about IoT enabling more efficient use of energy with the integration of various devices and systems, such as temperature control systems and humidity control systems, thus saving operational costs, received a percentage of 50% agree. The fifth question about IoT allows teachers to be more active in the learning process with the integration of various devices and systems, such as tablets and projectors, thereby increasing teacher involvement in the learning process, 60% strongly agree. The sixth question regarding IoT allows more effective management of school facilities with the

integration of various devices and systems, such as irrigation systems and preservation systems, thus improving the quality of school facilities, 20% disagreed.

The seventh question that IoT allows for more effective classroom management with the integration of various devices and systems, such as temperature control systems and humidity control systems, thereby increasing the efficiency of classroom management, received a percentage result of 65% agree option choices. In the eighth question, IoT allows students to be more active in the learning process with the integration of various devices and systems, such as tablets and projectors, thereby increasing student involvement in the learning process, also found in the choice of agreed options as much as 45%. The ninth question about IoT devices can detect damage or malfunctions in classroom equipment before they occur, helping to prevent learning disruptions and save costs, got a percentage result of 70% who agreed. For the last question about IoT can automate administrative tasks such as attendance, assessment, and data recapitulation, freeing up teacher time to focus on interactions with students, getting a percentage of 55% in the choice of option strongly agree.

Table 3. Recap of Percentage Results from Student Respondent Answers

No.	Question	Strongly Agree	Agree	Somewhat Agree	Disagree
1	Students can access information and learning materials in real-time via IoT devices in the classroom, increasing engagement and learning independence	35%	50%	10%	5 %
2	IoT data about student performance and learning styles can be used to personalize learning materials and provide appropriate support	50%	45%	3%	2%
3	IoT sensors can monitor student movements and activities in class, helping teachers identify potential distractions and increase learning	64%	30%	4%	2%

	focus				
4	Students' digital skills and ability to adapt to IoT technology will be a valuable asset in the ever-evolving world of work	45%	45%	7%	3%
5	IoT data can help policy makers in the education sector to make more precise and effective decisions	62%	28%	8%	2%
6	IoT data about teaching and learning processes can be used to increase accountability and transparency in the education system	35%	58%	5%	2%
7	IoT technology can help bridge educational gaps and ensure equal access to learning opportunities for all students	72%	28%	0%	0%
8	IoT can facilitate communication and collaboration between teachers, students, and parents, improving overall learning support	44%	40%	16%	0%
9	IoT enriches learning with the use of various devices and systems, such as tablets and projectors, thereby improving the quality of learning	75%	20%	5%	0%
10	IoT enables more efficient use of school resources by integrating various devices and systems, such as lights and air conditioning, thereby saving operational costs	45%	50%	2%	3%

In the table 3 statement above, researchers have also made ten questions. Which can be seen from the first question regarding Students can access information and learning materials in real-time through IoT devices in the classroom, increasing learning engagement and independence, getting a percentage score of 50% agreed options. Next question number two about IoT data on student performance and learning styles can be used to personalise learning materials and provide appropriate support, getting a percentage score of 50% strongly agree option. The third question that IoT sensors can monitor student movement and activity in the classroom, helping teachers identify potential distractions and improve learning focus, received a percentage score of 64% strongly agree.

The fourth question about The digital skills and adaptability to IoT technology that students have will be a valuable asset in the ever-evolving world of work, received a 45% percentage score on the option choice of agree. The fifth question about IoT data can help policy makers in the field of education to make more informed and effective decisions, got 62% of the option choices strongly agree. The sixth question about IoT data on the teaching and learning process can be used to increase accountability and transparency in the education system, also received the same percentage of 58% in the agree option.

The seventh question about IoT technology can help bridge the education gap and ensure equal access to learning opportunities for all students, scored a percentage of 72% strongly agree. The eighth question about IoT can facilitate communication and collaboration between teachers, students, and parents, improving overall learning support, received a percentage score of 44% strongly agree. In question number nine that IoT enriches learning with the use of various devices and systems, such as tablets and projectors, thus improving the quality of learning, is also found in the most option choices strongly agree as much as 75%. The last question about IoT allows more efficient use of school resources with the integration of various devices and systems, such as lights and air conditioners, thereby saving operational costs, received 45% in the choice of strongly agree option.

Diagram 1

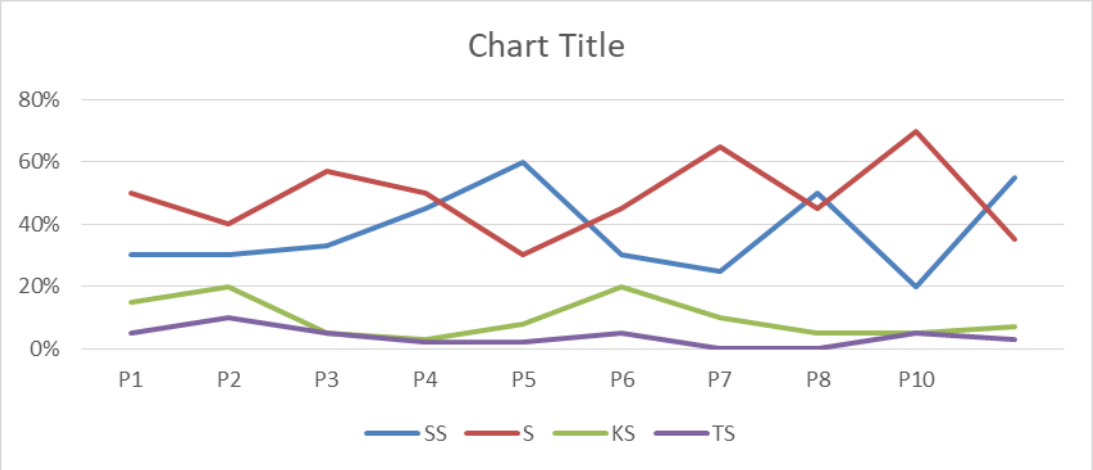

Diagram 2

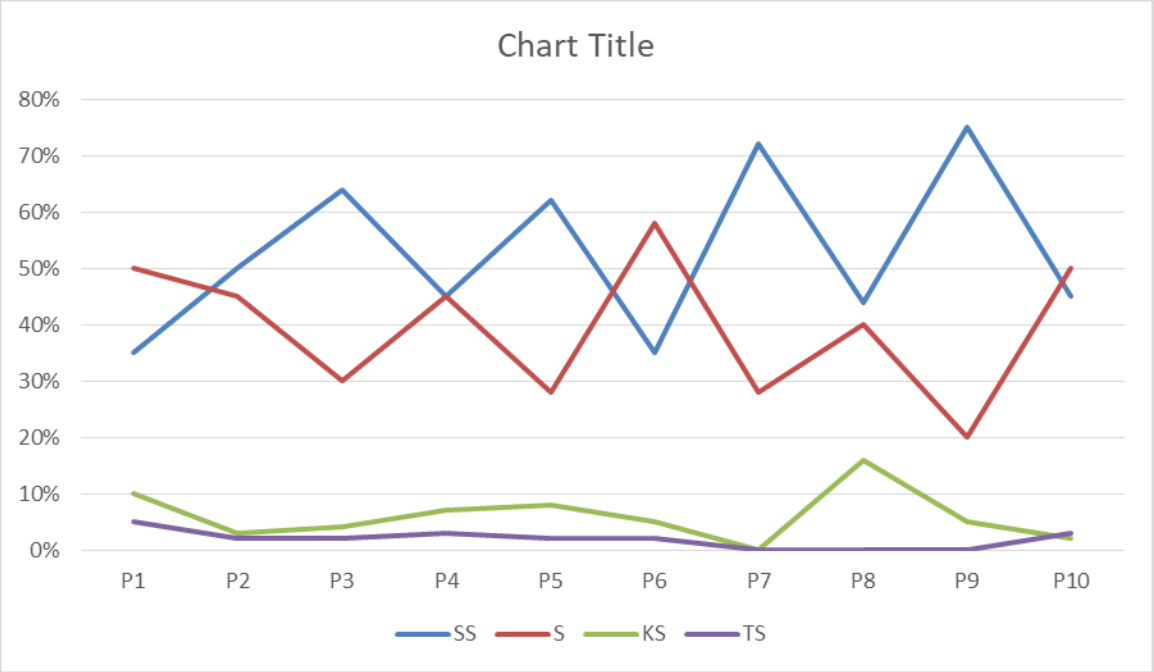

Table 3. T-test on the impact of the integration of Internet of Things (Iot) technology in learning on the efficiency of classroom management for teachers

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE TEST	45.2500	20	15.72419	3.51603
	POST TEST	44.0500	20	13.02417	2.91229

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PRE TEST & POST TEST	20	-.886	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PRE TEST - POST TEST	1.20000	27.92396	6.24399	-11.86881	14.26881	.192	19	.850

Based on the results of table 3 above, it is a T-test using the SPSS application. From the results of the study, researchers can conclude that the T-test test in the first output section explains Mean as an average. In the Pre Test, the average number produced was 45.2500, while in the Post Test section it was 44.0500. Based on these results it can be formulated that there is a difference from the results of the respondents' answers. Furthermore, in the Paired Samples Correlations section, obtaining Correlations of -886, as well as a large sig of 000. Furthermore, in the Paired Samples Test section, the results obtained were 27.92396 in the Std. Deviation section, while in

the Std. Based on these results, the impact of the integration of internet of things (iot) technology in learning on the efficiency of classroom management for teachers.

Table 4. T-test of the Impact of the Integration of Internet of Things (Iot) Technology in Learning on the Efficiency of Classroom Management for Students

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE TEST	7.9000	20	5.72069	1.27919
	POST TEST	2.8000	20	2.50473	.56008

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PRE TEST & POST TEST	20	.524	.018

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PRE TEST - POST TEST	5.10000	4.89791	1.09520	2.80771	7.39229	4.657	19	.000

Furthermore, in table 4, it is also the result of research using the T-test. It can be seen in the first output section from the acquisition of the Pre Test results of 7.9000, and the Post Test of 2.8000. In the Paired Samples Correlations section, obtaining

Correlations of 524, with the acquisition of Sig results of 018. While in the Paired Samples Test section, obtained results of 4.89791 in the Std. Diviation, and Std. Error Meanya as much as 1.09520. Based on the results of this study, it can be seen between each question asked by researchers regarding the impact of the integration of internet of things (iot) technology in learning on the efficiency of classroom management for students.

Internet of Things (IoT) is a term that refers to a network of devices, vehicles, buildings, physical objects, and other items equipped with sensors, software, and other technologies that allow them to connect and share data with other devices and systems over the internet (Ramalho et al., 2019). This concept is becoming increasingly important in various industries, including industrial environments, known as the Internet of Things (IoT) (Sinha et al., 2019). It is projected to grow rapidly in the coming years. Internet of Things technology allows people, processes, and things to communicate easily, which enables data collection and sharing without human intervention (Shahidul Islam et al., 2019). In areas such as retail, logistics, transport, and healthcare, these technologies have been widely used. By doing so, they can increase efficiency, improve customer experience, and generate new revenue streams.

Various technologies, such as low-cost computing, cloud, big data, analytics, and mobile technologies, underpin the Internet of Things infrastructure, which enables data exchange between devices and systems (Hussain & Beg, 2019). With the incorporation of machine learning algorithms, the Internet of Things ecosystem is expanding, enabling massive analyses of sensor data connected to the cloud (Verma et al., 2022). Consequently, the merging of the Internet of Things with machine learning and other technologies has resulted in the development of intelligent applications that can analyse and display Internet of Things data, providing information on key performance indicators (Caro & Sadr, 2019). The applications of the Internet of Things are diverse and widespread, ranging from smart home devices to industrial automation systems (Al Hayajneh et al., 2020).

Mobile applications can be used to remotely control smart home devices, while industrial IoT applications have the ability to optimise production processes and improve product quality (Al-Turjman & Lemayian, 2020). By providing real-time data

and enabling more efficient decision-making, the Internet of Things (IoT) helps improve public services such as utility management and emergency response systems (Manavalan & Jayakrishna, 2019). In Indonesia, the adoption of the Internet of Things is increasing, and there are many initiatives and programmes to encourage the use of IoT in various industries, such as energy, transportation, and Health services (J. Wang et al., 2021). In order to benefit from the Internet of Things, the Indonesian government has conducted projects such as smart metering systems and vehicle tracking.

In addition, private companies such as Telkom have developed Internet of Things-based services such as e-health, e-logistics, and e-tourism to improve their operational efficiency (Safaei Pour et al., 2020). Overall, the Internet of Things (IoT) has become an important technology in the modern world that has opened up many opportunities and advantages for innovation in various industries and sectors (Wu et al., 2022). When Internet of Things (IoT) technology is incorporated into the learning process, it significantly improves the quality and efficiency of the learning process (Alshehri & Hussain, 2019). IoT allows traditional methods to be combined with new methods by using sensors and connected technologies (Singh et al., 2020). This results in a more interactive and dynamic learning process.

IoT also allows students to be more engaged in the learning process, increasing their retention and understanding of complex subject matter (Mumtaz et al., 2021). In addition, the Internet of Things allows teachers to monitor student progress in real-time and identify students who require more attention, resulting in a more efficient time relationship between teachers and students (Ali et al., 2022). Therefore, incorporating the Internet of Things (IoT) into the learning process has positive effects that increase efficiency, reliability, and innovation and improve the overall learning process (Yadav et al., 2021).

By incorporating Internet of Things (IoT) technology into the education process, the efficiency of classroom management is significantly improved (Koroniotis et al., 2019). By using sensors and connected technologies, the Internet of Things allows teachers to monitor student progress in real-time and identify students who need more attention, resulting in time efficiency between teachers and students (Shafiq et al., 2020). In addition, IoT allows teachers to personalise learning by providing specific

information about students' needs and learning styles, making the learning experience more relevant and significant for each student (Chatfield & Reddick, 2019).

CONCLUSION

The integration of Internet of Things (IoT) technology in education has a significant impact on improving classroom management efficiency. By utilizing sensors and connected technology, IoT allows teachers to monitor student progress in real-time and identify students who need more attention, creating time efficiencies between teachers and students. Additionally, IoT enables personalization of learning by providing specific information about student needs and learning styles, creating a more relevant and meaningful learning experience for each student. Thus, the application of IoT brings a positive transformation in optimizing the educational process, increasing efficiency, reliability and innovation in classroom management.

By incorporating Internet of Things (IoT) technology into the learning process, classroom management efficiency is significantly increased. By using sensors and connected technology, the Internet of Things allows teachers to monitor student progress in real-time and identify students who need more attention, creating time efficiencies between teachers and students. In addition, IoT allows teachers to personalize learning by providing specific information about students' needs and learning styles, so that the learning experience becomes more relevant and significant for each student.

By collecting data in real-time, the Internet of Things also improves the performance of industrial computer infrastructure and enables more accurate and efficient facility management. In the world of education, the Internet of Things enables the use of biometric data to accurately monitor student attendance, enable students to access learning materials, and communicate directly with their teachers. In addition, by integrating various school resources, such as lights and CCTV, in one application, it allows officers to access information easily. Therefore, the use of the Internet of Things has a positive impact on classroom management and educational infrastructure, increasing efficiency, reliability and innovation in the educational process.

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