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Introduction Internet of Things Design for Students in SMKs Darul Ulum Layoa Bantaeng

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A b s t r a c t

IoT (Internet of Things) technology is currently experiencing very rapid development. Several innovative and creative applications, most IoT-based, have been found. IoT underlies the existence of smart home technology. One of the advantages of smart home technology is that homeowners can control conditions and monitor home security using only one device. Unfortunately, at SMKs Darul Ulum Layoa, Bantaeng, Sulawesi Selatan (South Sulawesi), learning about IoT still needs to be improved. It becomes the basis for why we hold a community service activity. This activity provided understanding and training on the Internet of Things, which 40 teachers and students attended. Pretest and posttest methods are used to determine the activity's success level. Both results were processed using the SPSS (Statistical Package for the Social Sciences) method. SPSS is a statistical software used to perform data analysis, including descriptive and inferential analysis. By utilizing the Wilcoxon Signed Rank Test, an analysis of the data revealed a Z value of -5.026 and a p-value of 0.000. These findings indicate a significant difference between the pretest and posttest groups or a significant increase in scores between the pretest and posttest. Therefore, the intervention had a positive effect on the outcome being measured.

Keywords: Bantaeng; Internet of Things; Pre-test and post-test; SPSS.

Introduction

Bantaeng Regency, situated in the southern part of South Sulawesi Province, encompasses a vast area of 395.83 km² or 39,583 ha. This region consists of two primary land categories: paddy land, spanning 7,253 ha (18.32%), and dry land, covering 32,330 Ha (Profil, n.d.). Administratively, Bantaeng Regency is divided into eight sub-districts, comprising 21 districts and 46 villages with a total population of 170,057 individuals (Bantaengkab.Go.Id, n.d.). Among the educational institutions in this district, SMKs Darul Ulum Layoa stands out as a prominent Vocational High School.

Situated in Layoa, Gantarang Keke Subdistrict, Bantaeng Regency, South Sulawesi, SMKs Darul Ulum Layoa operates as a vocational high school (SMK), with its primary objective of preparing students for employment in the dynamic world of business and industry (antaranews.com, 2019). SMKs offer a range of majors tailored to meet the needs of the business and industrial sectors (Maulina & Yoenanto, 2022). Notably, one area of study that has experienced rapid development is the Internet of Things (IoT). This technology revolutionizes daily lives by facilitating integrated systems for monitoring and controlling internet communication usage and deploying various computing forms and applications (Ozdil & Ozbilen, 2014). Furthermore, IoT has been identified as a viable solution for addressing contemporary health concerns (Prajoona Valsalan *et al*., 2020). Consequently, incorporating IoT into the curriculum for SMK students specializing in Computer and Network Engineering (TKJ) becomes imperative (Budihartono et al., 2022).

However, since including the Internet of Things curriculum, SMKs Darul Ulum Layoa Bantaeng has encountered several obstacles that hinder effective learning. These challenges primarily stem from limited access to information and a shortage of qualified teaching staff. A significant hurdle the school faces is the need for teachers and instructors who comprehensively understand IoT and smart ome technologies. Previous surveys and interviews have revealed that students heavily rely on YouTube tutorials for assembling IoT devices. However, the vast array of information on YouTube challenges teachers, who require more reliable and comprehensive resources to keep pace with the rapidly evolving technological landscape (Abu-Taieh *et al*., 2022). The lack of accurate information has resulted in damage to electrical equipment, such as Arduino boards, lights, switches, and more, due to short circuits.

These constraints faced by the school have raised our concern and motivated us to embark on a community service project focused on providing a solid foundation in IoT. We aim to enhance knowledge about the relationship between IoT and smart homes. Considering that smart home technology is an integral part of the broader Internet of Things (IoT) landscape (Doja *et al*., 2023)., conducting training activities at schools like SMKs Darul Ulum Layoa becomes crucial in implementing and disseminating valuable knowledge concepts. Through our community service efforts, we aspire to contribute to the community's education as part of a comprehensive strategy. By addressing the school's challenges, we endeavor to empower teachers and students with the necessary skills and knowledge to harness the potential of IoT and pave the way for a technologically advanced future.

Research Method

We implemented a range of methodologies in our community service initiatives to ensure comprehensive data collection and analysis. On January 16, 2023, we conducted our community service activity at Darul Ulum Layoa Vocational School in Bantaeng. To gather quantitative data, we employed various approaches, including distributing questionnaires to respondents (Septiawati et al., 2023). As part of our methodology, we initiated the process by administering a pretest to evaluate the participants' baseline level of knowledge. This pretest allowed us to gain insights into their current understanding of the subject matter before any intervention occurred. By assessing their initial learning, we could effectively measure the impact and effectiveness of our intervention. Subsequently, we conducted an introductory session to familiarize the participants with the subject matter, followed by comprehensive training on the Internet of Things (IoT). To evaluate the impact of the movement, we administered a post-test, enabling a comparison of the participants' performance before and after the training. The data collected through these tests were further processed using the SPSS statistical analysis software. We were fortunate to engage 40 participants who actively completed the questionnaire, which significantly enhanced the reliability and significance of our findings. The procedural steps implemented in this study aim to achieve our research objectives and obtain optimal results. Figure 1 visually represents the steps involved in the research process.

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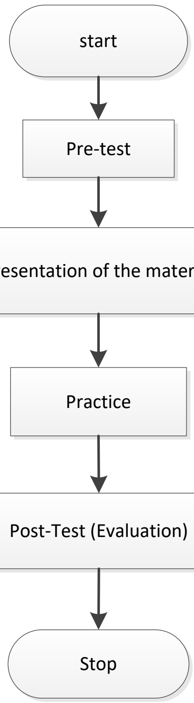

Figure 1. Research Process

With great anticipation for the commencement of the activity, the school spared no effort in orchestrating a meticulously planned and splendid opening ceremony. Every detail was thoughtfully curated to mark the momentous beginning of the event, emphasizing its profound significance. The remarkable occasion was meticulously documented, capturing the essence and spirit of the inaugural proceedings in a visually captivating snapshot depicted in Figure 2. This artistic portrayal evokes a profound sense of awe and inspiration, serving as a testament to the magnitude of the occasion and the collective enthusiasm it generated.

Figure 2. Opening Ceremony

The primary objective of conducting a pretest is to establish a baseline level of knowledge, skills, or performance before introducing an intervention or program. By conducting a pretest, researchers and educators can effectively monitor the changes that arise as a direct outcome of the intervention, thereby facilitating the evaluation of the program's overall effectiveness. Additionally, pretests serve several other purposes, including:

- Identifying areas of strength and weakness in individuals or groups before implementing the intervention will enable tailored program design to meet their specific needs
- Identifying individuals or groups who may require additional support to ensure their success in the intervention
- Identifying individuals or groups with exceptional abilities and allowing their engagement with more advanced material and challenges
- Establishing benchmarks that can be used to compare results with future assessments or similar studies
- Assisting educators and researchers in evaluating the effectiveness of curricula, programs, or policies

In summary, pretests serve as valuable tools for researchers and educators to assess the current state of their study population and set benchmarks for future evaluations. Figure 3 visually portrays the implementation of the Pretest.

Figure 3. Preparation of Participants before the Pretest

After completing the 15-minute pretest, the participants eagerly transitioned to the next segment, which entailed an insightful theoretical presentation on the intriguing subject of the Internet of Things. To facilitate immediate hands-on application, we divided the attendees into groups (Itasari & Hastuti, 2022), enabling them to practice the knowledge they had acquired effectively. The material was expertly presented by Mr. Muhammad Rizal, S.Kom., M.T., capturing the audience's attention. Figure 4 beautifully portrays captivating photographs that immortalize the dynamic delivery of the material, reflecting the participants' active engagement and palpable enthusiasm throughout the session.

Figure 4. Delivery of theMaterial

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Internet of Things technology refers to the network of physical devices, vehicles, buildings, and other items embedded with electronics, software, sensors, and connectivity that enables these objects to establish connections and share information. IoT allows data collection and analysis from various sources, as well as new insights, automation, and control. IoT and artificial intelligence (AI) are the leading technologies of the fourth industrial revolution (or industry 4.0), which humans can use to protect systems that are connected to the internet (Sarker *et al*., 2021). IoT training-introduction usually includes the following topics:

- A general description of IoT concepts and technology, including sensors, actuators, and communication protocols
- IoT architecture and design, including device communication to the cloud and cloud-to-cloud
- IoT data management, including storage, processing, and data analysis
- IoT security, including methods for protecting devices, data, and networks from unauthorized access and attacks
- Applications and cases of the use of IoT, including intelligent houses, industrial automation, and connected vehicles
- IoT development tools and platforms, including programming languages, software development kits, and cloud services
- Practical training will include direct experience building IoT projects, working with sensors and microcontrollers, and programming in Python or Javascript. It can also include the introduction of IoT platforms such as AWS IoT, Azure IoT, and Google Cloud IoT.

This training program provides participants with the knowledge and skills to create IoT-based tools (Prajoona Valsalan et al, 2020) for controlling light using smartphones. The ability to control lighting is essential for energy optimization in smart cities (Chen *et al*., 2022). Participants can explore and practice implementing simple IoT technology through practical exercises and demonstrations, as depicted in Figure 5. By the end of the training, participants will have acquired the necessary abilities and expertise to create efficient lighting control systems using IoT technologies.

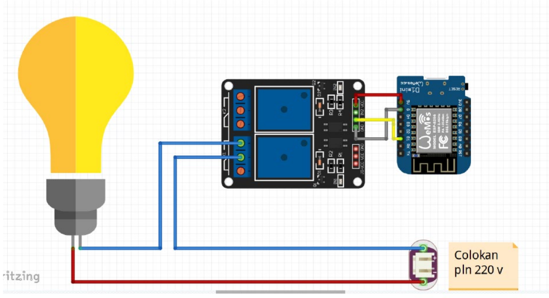

Figure 5. IoT-Based Tool to Control the Lamp

Lastly, we did a post-test. A post-test is an assessment given after an intervention or program has been completed. Its purpose is to assess the impact of the intervention and evaluate the program's effectiveness by measuring the observed change. The posttest is usually similar in format and content to the pretest, and the results are compared with those of the pretest to measure changes. The primary purpose of the posttest is to evaluate the effectiveness of an educational intervention or program. However, there are several testing methods, such as the confusion matrix for image processing (M. Rasyid *et al*., 2019) (M. F. Rasyid, 2022) and object detection (F. Rasyid *et al*., 2022). However, pretest and posttest are more effective for measuring the level of training success. Researchers can determine how the intervention achieved the desired goals by comparing the pretest and posttest outcomes. The questions we use are the same as those during the pretest.

Results & Discussion

To measure the level of success of this community service activity, we used the pretest and posttest methods. Both tests were conducted to determine the participants' basic knowledge of the material to be presented. Furthermore, the results of the two tests were processed using SPSS software. SPSS, commonly known as the Statistical Package for Social Sciences, is a software tool extensively utilized for statistical analysis in the field of social sciences. SPSS also provides a user-friendly interface, making it easy to enter and manipulate data, create tables and charts, and run statistical tests.

The pretest was conducted to measure the participant's basic knowledge of IoT. This test is carried out before the workshop begins. Five multiple-choice questions make up the pretest. Any given answer choice might be worth anything from 0 to 100 points. Figure 6 displays the results of the test.

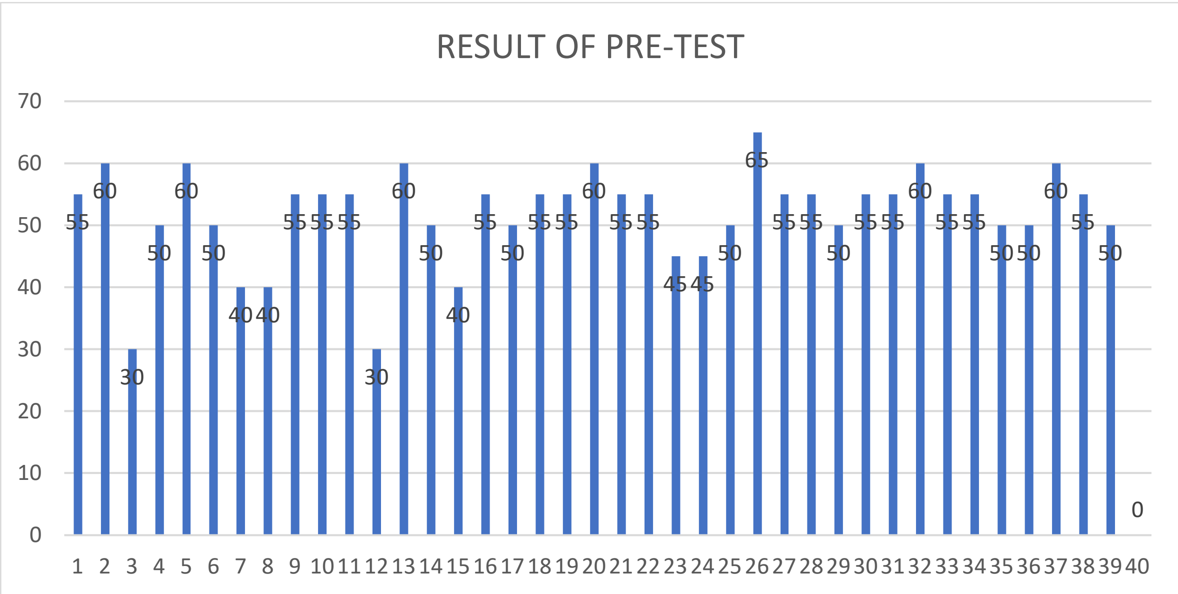

Figure 6. The Result of Pretest

The preceding visual representation offers valuable insights into the individual performance of each participant. Among the 40 individuals who took part in the examination, the highest score was 52, whereas the lowest score was 30. The workshop participants exhibited an average score of 50.625, indicating a moderate level of proficiency.

After the workshop, a comprehensive posttest was administered to gauge the participants' knowledge acquisition of IoT. The structure of the posttest closely mirrored that of the pretest, ensuring consistency and comparability in the assessment. The posttest comprised five multiple-choice questions, each with a point value from 0 to 100 for each answer choice. The participants were required to select the most appropriate response for each question based on their understanding of IoT concepts and applications.

The posttest findings, illustrated in Figure 7, provide a comprehensive overview of the participants' performance and serve as a valuable source of information for evaluating the workshop's effectiveness. The visual representation showcases the distribution of scores and highlights the range of knowledge demonstrated by the participants. By examining the results, researchers and educators can identify areas of strength and those that require further improvement, which allows for targeted interventions and tailored instructional approaches in future workshops.

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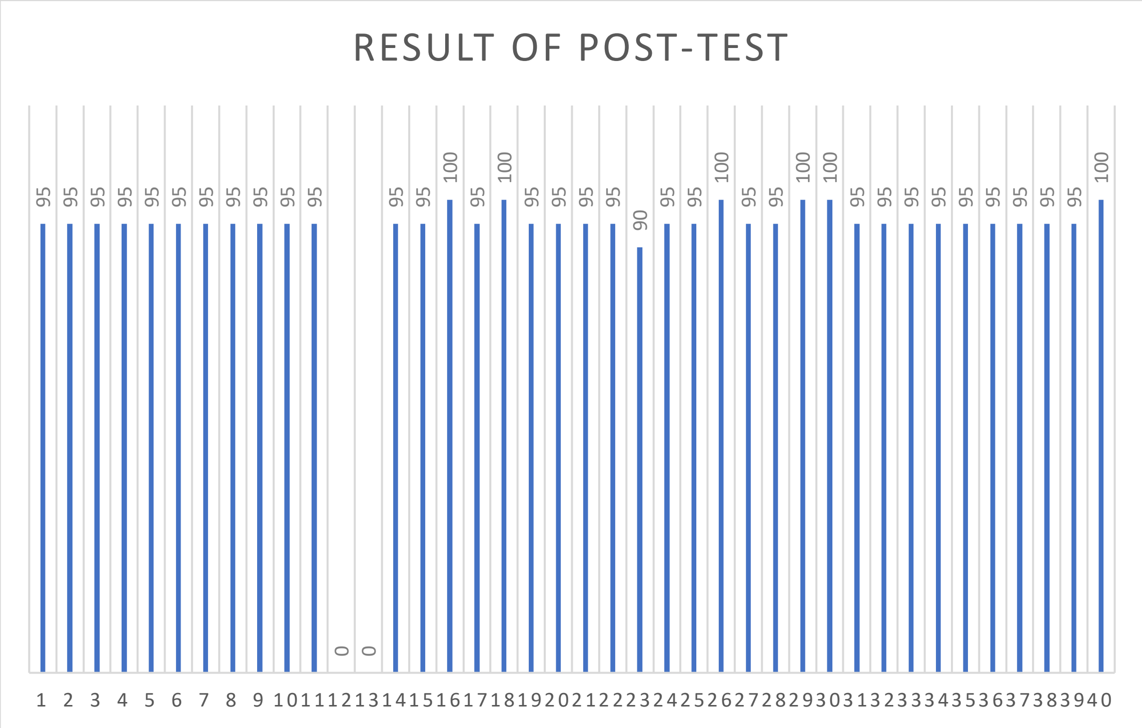

Figure 7. The Result of Posttest

The analysis of post-test results contributes to a broader understanding of the participants' knowledge acquisition and the overall impact of the workshop on their IoT proficiency. Moreover, it serves as a benchmark for assessing the effectiveness of the training program in achieving its intended learning outcomes. Through careful examination and interpretation of the post-test data, educators and researchers can make informed decisions regarding instructional strategies, content modifications, and the development of future training initiatives in IoT. Using post-test assessments, in conjunction with pretests, provides a comprehensive framework for evaluating the effectiveness and impact of educational interventions. By comparing the pretest and post-test scores, researchers can measure the progress made by participants and ascertain the extent to which the workshop contributed to their knowledge growth. This comparative analysis enables researchers and educators to determine the workshop's effectiveness in achieving its objectives and identify areas for further refinement and enhancement.

In summary, visualizing participant performance through the provided image offers valuable insights into the workshop outcomes. The subsequent administration of a post-test assessment serves as a crucial means of evaluating the participants' level of knowledge acquisition. By analyzing the post-test data, researchers and educators can gain valuable insights into the workshop's impact on participants' IoT proficiency, identify areas for improvement, and inform future instructional practices in the field. The graph below shows the acquisition value of each participant. Of the 40 participants who took the exam, the top score was 100, while the lowest was 90. The average score of the 40 workshop participants was 90.875. A rise in the mean score from the pretest to the post-test showed the success of the training (Wongkia & Poonpaiboonpipat, 2022). The graph of the average pretest and post-test scores can be seen in Figure 8.

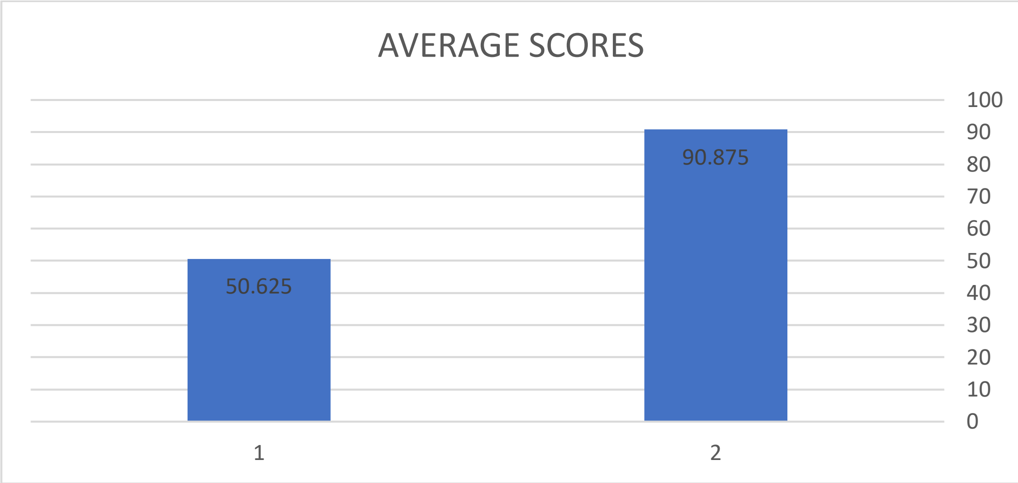

Figure 8. Chart of Average Scores: (1) Pre-test and (2) Post-test

In this study, we employed Wilcoxon non-parametric statistics and SPSS to analyze and compare the pretest and post-test data. Utilizing this statistical method allowed us to test the hypothesis (H1) that a significant difference exists between the scores obtained in the pretest and post-test assessments. Additionally, the Wilcoxon test enables us to determine whether there is an increase in scores from the pretest to the post-test (Saplıoğlu & Güçlü, 2022). It is worth noting that the Wilcoxon test is commonly employed for testing location parameters, making it well-suited for our evaluation (Kitani & Murakami, 2022). The results of the Wilcoxon test are presented in Table 1, providing a comprehensive overview of the statistical analysis conducted on the pretest and post-test data. Through this analysis, we aim to ascertain the extent of the differences between the two groups and gain insights into the effectiveness of the intervention or program under examination.

Table 1
Descriptive Statistics

Type	N	Minimum	Maximum	Mean	Std. Deviation
Pre Test	40	0	65	50.63	11.162
Post Test	40	0	100	90.88	21.210
Valid N (Listwise)	40				

The table above shows each data group's mean value, standard deviation, minimum, and maximum (pretest and post-test). The mean or average post-test value is 90.88, greater than the pretest value of 50.63. It is essential to utilize appropriate statistical methods in research to ensure the validity and reliability of the findings. The Wilcoxon test, being a non-parametric method, offers several advantages in situations where the assumptions of parametric tests are not met or when dealing with ordinal or non-normally distributed data. By employing this statistical approach, we can obtain robust and reliable results that will enhance the accuracy and credibility of our study. Furthermore, using SPSS software provides a robust platform for conducting statistical analyses, allowing for efficient data processing, manipulation, and interpretation. Integrating SPSS with the Wilcoxon test enables us to perform advanced statistical procedures and generate valuable insights from our data. Then the Wilcoxon Signed Rank Test was conducted to compare the previous tests (Pretest and post-test) (Ohyver *et al*., 2019). This test is shown in Table 2.

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Table 2
Rank of Pretest and Posttest

Type	N	Mean Rank	Sum of Ranks
Negative Ranks	2[a]	19.50	39.00
Positive Ranks	38[b]	20.55	781.00
Ties	0[c]		
Total	40		

Explanations:

a =Post Test < Pre Test
b =Post Test > Pre Test
c =Post Test = Pre Test

The Wilcoxon Signed Rank Test formula utilizes a calculation method that yields various values, including the mean rank, sum of ranks of negative ranks, positive ranks, and ties. Negative ranks indicate that the second group (post-test) samples have lower values than the first group (Pretest). Conversely, positive ranks represent samples with higher values in the second group (post-test) than in the first group (Pretest). Ties occur when the values in the second group (post-test) equal those in the first group (Pretest). The symbol "N" denotes the number of observations, "Mean Rank" refers to the average rank, and "Sum of Ranks" signifies the total sum. These calculations reveal a significant increase in knowledge between the pretest and post-test results among the participants. The analysis demonstrates that the training has effectively enhanced participants' understanding of the Internet of Things, as indicated by the significant improvement in their post-test scores. This finding underscores the impact and efficacy of the training program in equipping participants with the necessary knowledge and skills related to IoT. The statistical analysis of the training's effectiveness is presented in Table 3, providing a comprehensive overview of the static test results. This table displays the relevant statistical measures, such as the p-value, which determines the significance of the observed changes. By examining the statistical outcomes, we can draw meaningful conclusions about the effectiveness of the training program and its impact on participants' knowledge and skills related to the Internet of Things.

Table 3
Statistic Test

Type	Post-test – Pre-test
Z	-5.026[b]
Asymp. Sig. (2-tailed)	.000

Explanation:

a= Wilcoxon Signed Ranks Test
b= Based on negative ranks

The Wilcoxon Signed Rank Test and the accompanying calculations and statistical analysis provide valuable insights into the changes observed in participants' knowledge levels following the training. The rigorous evaluation of these results enhances our understanding of the training's effectiveness and contributes to the existing body of knowledge in IoT education. In summary, applying the Wilcoxon Signed Rank Test and the relevant statistical calculations and analysis enables us to identify significant improvements in participants' knowledge of the Internet of Things after attending the training.

Conclusions

The evaluation results obtained from the pretest and post-test administered to all training participants at SMKs Darul Ulum Layoa in Bantaeng revealed a significant improvement in their average scores. The average score increased from 50.625 to 90.875, representing a substantial increase of 40.25 points. This notable enhancement signifies a significant improvement in the participants' abilities, including teachers and students. The statistical analysis using the Wilcoxon Signed Rank Test confirmed the significance of the results. The calculated Z value of -5.026b and a p-value (Asymp. Sig 2 tailed) of 0.000 indicates a clear distinction between the pretest and post-test groups.

Consequently, there is a considerable increase in scores between the two tests. The decision to accept H1, which implies a significant difference, aligns with the critical research limit of 0.05. These findings imply that the training program on the Internet of Things positively impacted the participants' knowledge and skills. The substantial increase in average scores demonstrates the effectiveness of the training in enhancing their understanding and capabilities in this domain.

Based on the analysis results, organizing similar training activities more frequently is highly recommended. These sessions would play a vital role in augmenting the participants' knowledge about the Internet of Things, further enhancing their skills and competencies. The significant improvement observed in this study underscores the importance of providing ongoing opportunities for teachers and students to expand their understanding of this rapidly advancing field. Moreover, the success of this training program serves as evidence of the efficiency and efficacy of the teaching methodologies and content delivered by Mr. Muhammad Rizal, S.Kom., M.T. His expertise and instructional approach have contributed significantly to the participants' learning outcomes. In conclusion, the evaluation results indicate a substantial improvement in the participants' knowledge and skills related to the Internet of Things. The findings support the notion that frequent training activities should be implemented to continuously enhance the participants' abilities and keep pace with the ever-evolving technological landscape.

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