



Enhancing physics experiment skills using smartphone sensors for teachers in sorong regency

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ARTICLE INFO	ABSTRACT
<p>Article history Received: 2024-10-26 Revised: 2025-03-02 Accepted: 2025-03-30 Published: 2025-04-14</p> <p>Keywords Physics experiment Physics learning Phyphox app Smartphone sensor Teacher's skill</p>	<p><i>This community service program designed to enhance physics experimental skills using smartphone sensors for high school teacher aims to introduce and train teachers in utilizing simple yet effective technology in physics education. By using smartphone sensors, the goal is to enable teachers to conduct experiments that are not only captivating but also easily accessible and relevant to daily life, thus boosting students' comprehension and interest. The program was conducted in two phases: first, a training session for teachers, followed by school visit with MGMP team to provide hands-on support, address any challenges teachers may encounter, and observe the implementation of the method. Furthermore, the effectiveness of the program was evaluated based on the results from both pre-assessment and post-assessment conducted on 20 teachers from MGMP group. The assessment results showed increases in understanding and preparing technology, collecting data, and analyzing and evaluating data. Despite several challenges such as limited access to compatible devices and varying levels of understanding regarding the concept, the training was overall successfully improved teachers' skills in applying the technology for physics experiment.</i></p>
<p>Kata Kunci Eksperimen Fisika Pembelajaran Fisika Aplikasi Phyphox Sensor Smartphone Ketrampilan guru</p>	<p>Peningkatan Keterampilan Eksperimen Fisika menggunakan Sensor Smartphone bagi Guru di Kabupaten Sorong. Program pengabdian masyarakat yang dirancang untuk meningkatkan keterampilan eksperimen fisika menggunakan sensor smartphone bagi guru SMA ini bertujuan untuk memperkenalkan dan melatih guru dalam memanfaatkan teknologi sederhana namun efektif dalam pendidikan fisika. Dengan menggunakan sensor smartphone, guru diharapkan dapat melakukan eksperimen yang tidak hanya menarik tetapi juga mudah diakses dan relevan dengan kehidupan sehari-hari sehingga meningkatkan pemahaman dan minat siswa. Program ini dilaksanakan dalam dua tahap: pertama, sesi pelatihan bagi guru, dilanjutkan dengan kunjungan sekolah bersama tim MGMP untuk memberikan dukungan langsung, mengatasi tantangan yang mungkin dihadapi guru, dan mengamati penerapan metode tersebut. Selanjutnya efektivitas program dievaluasi berdasarkan hasil pre-assessment dan post-assessment yang dilakukan pada 20 orang guru kelompok MGMP. Hasil penilaian menunjukkan peningkatan dalam aspek ketrampilan memahami dan menyiapkan teknologi, aspek ketrampilan mengumpulkan data, dan aspek ketrampilan menganalisis dan mengevaluasi data. Meskipun terdapat beberapa tantangan seperti terbatasnya akses terhadap perangkat yang kompatibel dan tingkat pemahaman konsep yang berbeda-beda, pelatihan ini secara keseluruhan berhasil meningkatkan keterampilan guru dalam menerapkan teknologi untuk eksperimen fisika.</p>

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INTRODUCTION

The improvement of human resources to compete in the era of globalization is greatly influenced by education, with physics education playing a vital role in enhancing analytical skills, problem solving abilities, and understanding of scientific concepts (Astari et al., 2024; Puspa et al., 2023; Walidin, 2016; Alfayani et al., 2024; Himawan et al., 2020; Sugianto et al., 2020). However, physics education encounters several challenges, including the perception that it is a difficult subject leading to rote memorization by students (Haerunnisa et al., 2022; Rabiudin et al., 2022). The challenge is clear from the significant amount of students struggling to comprehend physics material and formulas (Ady & Warliani, 2022; Azizah et al., 2015; Daun et al., 2020). The effective way to study physics requires direct observations or experiments to ensure students truly understand the concepts (Nova & Lestari, 2021; Sahrudin et al., 2019; Sarjono, 2018).

Musyawarah Guru Mata Pelajaran (MGMP) Fisika has been active in Sorong Regency since 2008 and it serves as a platform for physics teachers to exchange knowledge and experiences with the aim of enhancing the quality of physics education. Comprising 29 teachers from 18 high schools in Sorong Regency, the group is supported by the local educational authorities. One of the challenges faced by this group is the limited availability of physics experiment equipment at school laboratories. Additionally, there is a need for significant funding for the development of laboratory facilities which detain the effectiveness of interactive learning and leads to a lack of direct experimental lessons for students.

In response to these issues, one potential resolution involves harnessing the sensor technology present in smartphones for conducting physics experiments. With the prevalent use of smartphones in both urban and remote areas, it has become an integral part of the digital age. In Indonesia, the number of smartphone users has seen significant growth, with an estimated 177 million active users in 2021 and a continued increase due to technological advancements and wider digital access (Rochmahwati, 2023). Smartphone penetration has also increased, with a 25.9% growth from 2019 to 2023 (Indriyani & Supriyadi, 2023). Additionally, a 2018 UNICEF study indicated that 98% of children and adolescents in Indonesia are familiar with the internet, with 79.5% accessing it through smartphones (Ikhwan et al., 2022). This provides an excellent opportunity to leverage existing technology as a more affordable and accessible tool for physics experiments.

The use of these sensors is expected not only to provide a more economical alternative but also to enhance the quality of learning by involving students more interactively (Countryman, 2014; Monteiro et al., 2015; Raharja & Ishafit, 2021; Vogt & Kuhn, 2012). One of the applications that can be used is phyphox, which allows smartphones to function as measurement tools in various physics experiments. This application has been utilized in experiments such as free fall motion, magnetic fields, the Doppler effect, sound waves, circular motion, cylindrical motion, and collisions (Ariyansah et al., 2021; Gianino, 2021; Hikmatiar, 2019; Islamiah et al., 2023; Nurfadilah et al., 2019; Putri et al., 2022; Walid, 2022; Westermann et al., 2022; Yani et al., 2023; Yasaroh et al., 2021). The results produced by the phyphox application have been used as references for data analysis in physics experiments to measure physical quantities (Carroll & Lincoln, 2020; Mayampoh et al., 2021; Staacks et al., 2022).

Considering the challenges and potential benefits, teachers need intensive training to effectively use this technology. The Physics Experiment Assistance Program Using Smartphone Sensor Technology for High School Teachers in Sorong Regency is a strategic initiative to address this issue. The goal of this community service is to improve teacher's technical abilities in conducting smartphone-based experiments, leading to a more interactive, innovative, and technology-focused approach to teaching physics. Furthermore, the program aligns with SDG4, Quality Education, by providing affordable smartphone-based experiment tools to overcome limitations in laboratory facilities and expand the access to quality education for all students. Additionally, the program aims to enhance teacher's skills, ultimately improving the overall quality of education in schools.

METHOD

This community service is an application of the results of research into the development of smartphone sensor modules and analysis of their use in traveling carnival (Raharja, Irianti, Lestari, & Kabes, 2024; Raharja, Irianti, Lestari, Londong, et al., 2024). The flowchart as Figure 1, illustrates the sequential steps of the program.

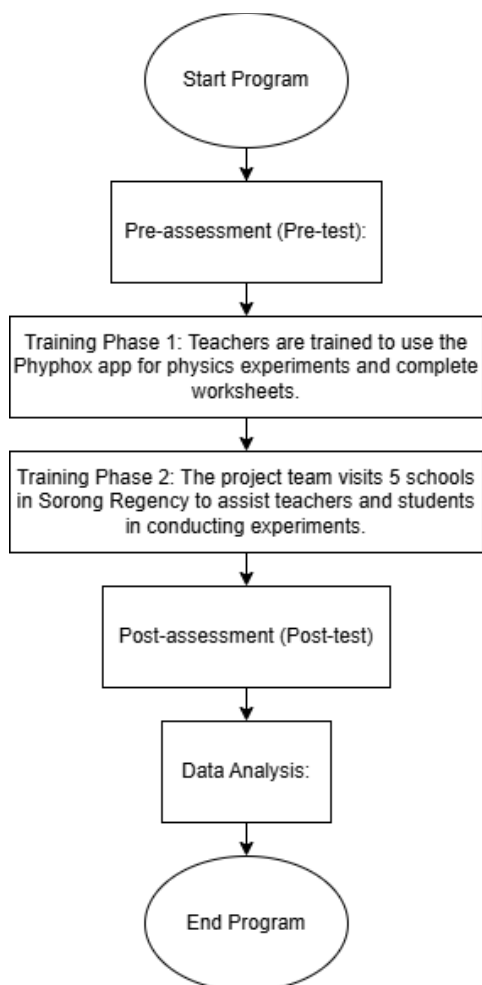


Fig 1. The steps of the program

The flowchart illustrates the structured approach of the training program, which was conducted in two phases to ensure effective implementation and evaluation. In the first phase, teachers from the MGMP Group were trained on how to perform physics experiments, such as free fall motion, circular motion, pendulum, and collision, using the Phyphox application. Throughout this phase, teachers were also required to complete worksheets to reinforce their understanding and practical skills. This initial training aimed to equip teachers with the necessary knowledge and confidence to integrate smartphone sensor technology into their teaching practices. Following this, the second phase involved the project team, consisting of 3 lecturers and 5 students from the Science Education Department, visiting five schools in Sorong Regency. These schools included SMA Negeri 1 Kabupaten Sorong, SMA Negeri 5 Kabupaten Sorong, MAN Insan Cendekia Kabupaten Sorong, SMA Negeri 2 Kabupaten Sorong, and SMK Modeling Salawati. During these visits, the team assisted teachers in conducting experiments with their students, ensuring that the knowledge gained during the training was effectively applied in real classroom settings.

To evaluate the program's efficacy, pre-assessment and post-assessment were conducted for the 20 MGMP Group teachers. The pre-test and post-test consisted of 10 identical questions focusing understanding and preparing technology, collecting experimental data, and analyzing and evaluating data. The pre-assessment was administered before the training began, while the post-assessment was conducted after the training and school visits. Responses were scored using a 5-point Likert Scale, ranging from (1) Strongly Disagree to (5) Strongly Agree. This scoring system allowed for a quantitative analysis of the teachers' progress and the program's overall impact.

RESULTS AND DISCUSSION

Training Activities

The training activity took place at SMA N 2 located in Aimas District, Sorong Regency Southwest Papua. A total of 20 physics teachers, 2 lecturers and 5 students of Science Education Department participated in the training. The activity was conducted in two main sessions, with the first session involving a material presentation then followed by a simulation.

In simulation session, teachers are divided into four groups where each group takes turn conducting experiment free fall motion, circular motion, pendulum and collision. The training activities are shown in Figure 2.



Fig 2. (a) presentation regarding Phythox by lecturer, (b) free fall motion using Phythox

School Visit

The project team paid a visit to multiple schools in Sorong Regency to assist teachers and students in conducting physics experiments using sensors based on smartphones. This visit was part of the follow-up stage of the training, where teachers had previously been trained to use the Phythox application for collecting and analyzing physics data. The process of assistance began with a brief introduction from the team about the steps of the experiment. Teachers, who had received prior training, then guided the students through conducting the experiments, while the team provided technical assistance and ensured that everything proceeded smoothly. Each student utilized their smartphones to measure various physics data, such as acceleration and speed using the sensors in their devices with the support of the Phythox app.

During the activity, the students actively participated in conducting the experiments, collecting and analyzing data in an interactive manner. Teachers played a facilitative role, guiding students to comprehend the underlying physics concepts of the experiments. Additionally, the training team assisted in interpreting the results and offering real-world applications for the collected data. This visit not only enabled teachers to apply the skills acquired during training but also exposed students to innovative learning approaches. By utilizing smartphone sensor technology, experiments that typically require complex laboratory equipment could be conducted more easily and affordably without compromising the quality of the learning experience. Following the activity, the team and teachers collaboratively evaluated the experiments to recognize successes and areas needing improvement. The project team visited SMA Negeri 1 Sorong Regency, MAN Insan Cendekia Sorong Regency, and SMA Negeri 5 Sorong Regency to support the implementation of physics experiments using the Phythox application, as shown in Figures 3, 4, and 5.



Fig 3. Project team paid a visit to SMA N 1 Sorong Regency



Fig 4. Project team paid a visit to MAN Insan Cendekia Sorong Regency



Fig 5. Project team paid a visit to SMA N 5 Sorong Regency

Evaluation

The assessment scores used for evaluating this training were obtained from pre-assessment and post-assessment score. An initial assessment was performed before the training to measure the teachers' comprehension and proficiency in conducting physics experiments, particularly in utilizing the Phyphox application. Following the completion of the training, a second assessment was carried out to assess the enhancement in teachers' skills. The assessment results were categorized into two parts: an overall evaluation of teachers' skills and an evaluation based on three different aspects i.e., understanding and preparing technology, collecting experimental data, and analyzing and evaluating data. The results of pre-assessment and post-assessment score are shown Figure 6.

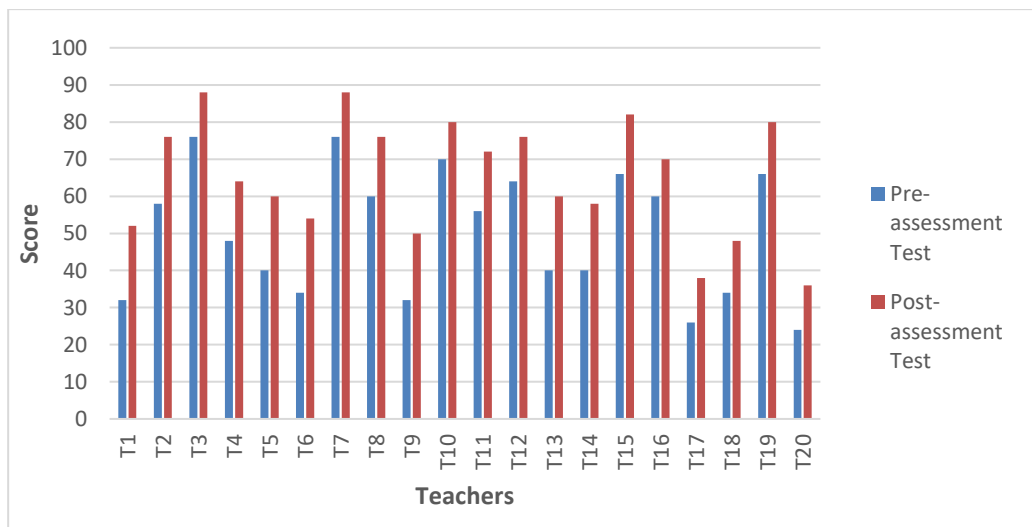


Fig 6. Pre-assessment and post-assessment score of teachers in conducting physics experiment by using Phyphox

In Figure 6, it can be seen that prior to the training, teachers' average score in conducting physics experiments with the Phyphox application was 48.7, suggesting that most teachers had a basic to intermediate skill level. Some teachers had a better understanding before the training, as indicated by the highest pre-assessment score of 76. On the other hand, the lowest score of 24 showed that some teachers encountered significant difficulties in mastering physics experiments before the training commenced. Following the training, there was a rise in the average score to 66.4, which indicates an enhancement in the proficiency of teachers in utilizing the Phyphox application, particularly in the areas of data collection and experiment analysis. The top score following the training stood at 88, underscoring substantial progress among teachers who already possessed strong skills. The lowest post-assessment score increased to 36, although some teachers still encountered difficulties. Moreover, the average improvement for all teachers amounted to 17.7 points, highlighting the effectiveness of the training. The greatest advancement was 26 points (e.g., T1: 32 to 52), while the smallest improvement was 12 points (e.g., T17: 26 to 38), affirming that all teachers made strides. Based on the analysis, the results can be broken down into several indicators shown in Figure 7.

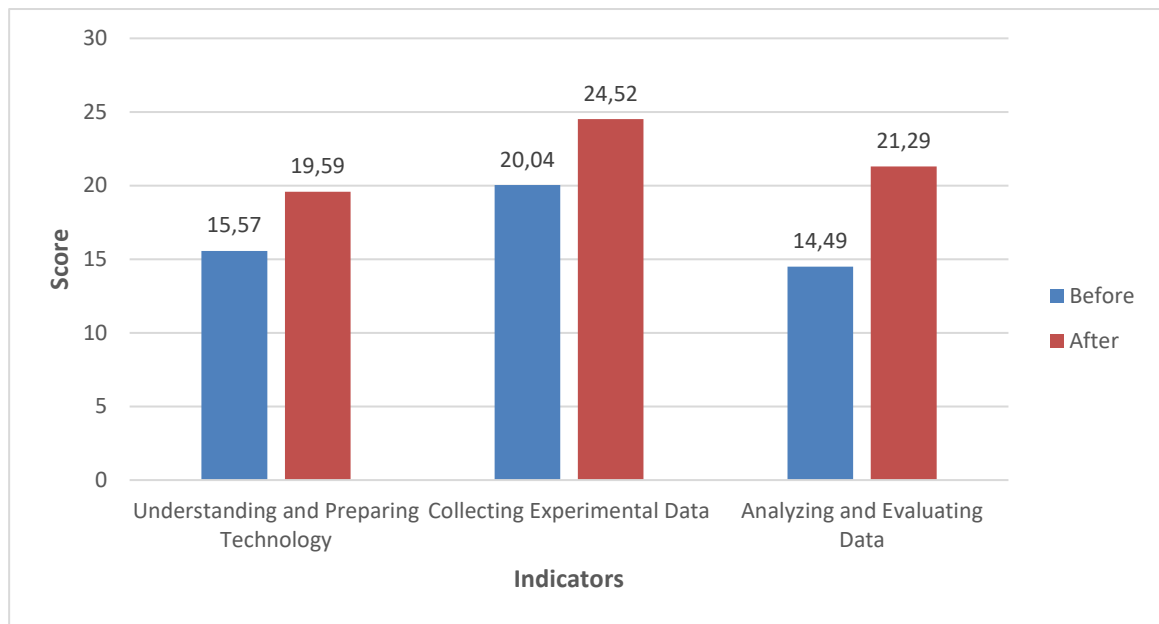


Fig 7. Assessment score are evaluated based on three aspects

In Understanding and Preparing Technology, the average score increased from 15.57 to 19.59, indicating that teachers developed a stronger grasp of the Phyphox application and its integration into physics experiments. For Collecting Experimental Data, the average score rose from 20.04 to 24.52, reflecting improved skills in accurately gathering and managing data during experiments. Lastly, in Analyzing and Evaluating Data, the average score improved from 14.49 to 21.29, demonstrating significant progress in teachers' ability to interpret, analyze, and draw conclusions from experimental results. These improvements across all indicators highlight the effectiveness of the training program in enhancing teachers' competencies in utilizing smartphone sensor technology for physics education.

Further analysis is essential to determine the significance of the program's performance before and after the training. The success rates for each indicator reveal notable improvements: Understanding and Preparing Technology saw a 25.8% increase (from 15.57 to 19.59), indicating enhanced teacher readiness in using the Phyphox application. Collecting Experimental Data improved by 22.4% (from 20.04 to 24.52), reflecting better skills in gathering and managing data. The most significant progress was in Analyzing and Evaluating Data, with a 46.9% increase (from 14.49 to 21.29), demonstrating a substantial boost in teachers' ability to interpret and evaluate experimental results. These percentages highlight the program's effectiveness in improving teacher competencies across all aspects, with the most remarkable impact on critical thinking and data analysis skills. Further statistical analysis could validate the significance of these improvements.

CONCLUSION

The program designed to enhance physics experimental skills using smartphone sensors for high school teacher aims to introduce and train teachers in utilizing simple yet effective technology in physics education. By using smartphone sensors, the goal is to enable teachers to conduct experiments that are not only captivating but also easily accessible and relevant to daily life, thus boosting students' comprehension and interest. Another benefit of this approach is that students get to work with real-time data during their learning experiences. The program was conducted in two phases:

first, a training session for teachers, followed by school visit with MGMP team to provide hands-on support, address any challenges teachers may encounter, and observe the implementation of the method. The assessment results indicate an improvement in teachers' abilities concerning the understanding and application of technology, data collection and data analysis and evaluation. Before the training, the average score of teachers in conducting physics experiments using the Phphox application was 24.75, indicating a basic to intermediate skill level, with some teachers struggling and others performing better. After the training, the average score rose to 34.55, with improvements particularly in data collection and experiment analysis. The highest post-training score reached 44, and the lowest was 18, indicating overall progress. Teachers' average improvement was 9.8 points, demonstrating the training's effectiveness. Skills assessment showed increases of 2.01 points in understanding and preparing technology, 2.24 points in collecting data, and 3.4 points in analyzing and evaluating data, highlighting comprehensive gains in experimental proficiency. Throughout the program, there were several challenges including limited experience in effectively utilizing the technology, restricted access to compatible devices, and varying levels of understanding regarding the concept. One of the follow-up strategies is to develop comprehensive guidelines and supporting materials that outline step-by-step instructions.

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