DOI: 10.14421/impulse.2023.31-02

IMPULSE: Journal of Research and Innovation in Physics Education
Volume 3, Issue 1, 9 – 18

© ISSN (p): 2798–1762; ISSN (e): 2798-1754
http://ejournal.uin-suka.ac.id/tarbiyah/impulse

Enhancing Science Process Skills in Physics Education: The Impact of the Phyphox Smartphone Application in High School Laboratories

Andio Calen Evains [1*], Santih Anggereni[1], Muh. Said L[1]

[1] Prodi Pendidikan Fisika, Universitas Islam Negeri Alauddin Makassar, Indonesia
*Corresponding author: calenevainsandio@gmail.com

ABSTRACT

This study explores the effectiveness of smartphones as measurement tools in physics laboratories, focusing on the science process skills of Class XI students at SMA Negeri 1 Wajo. Employing a Pre-Experimental One-Shot Case Study design, we integrated the Phyphox application into the curriculum and analyzed its impact on students' scientific understanding. Our methodology included purposive sampling of 24 students and data collection via science process skill tests, lesson plans, and student worksheets. Descriptive and inferential statistical analyses revealed a significant improvement in students' science process skills, with an average score of 72.08. The one-sample t-test showed an essential value of 0.000, indicating a positive effect of the Phyphox application. These findings suggest a potential shift towards technologically integrated learning environments in physics education, enhancing student engagement and comprehension. While promising, the study acknowledges its sample size and context limitations, highlighting the need for further research in diverse educational settings. This study contributes to the growing body of research advocating digital tools in education, aiming to prepare students for a technologically advanced world.

INTISARI

Penelitian ini mengeksplorasi efektivitas smartphone sebagai alat ukur dalam laboratorium fisika, dengan fokus pada keterampilan proses sains siswa kelas XI SMAN 1 Wajo. Menggunakan desain Studi Kasus One-Shot Pre-Eksperimental, kami mengintegrasikan aplikasi Phyphox ke dalam kurikulum dan menganalisis dampaknya terhadap pemahaman ilmiah siswa. Metodologi kami termasuk sampel purposif dari 24 siswa, dan pengumpulan data melalui tes keterampilan proses sains, rencana pelajaran, dan lembar kerja siswa. Analisis statistik deskriptif dan inferensial mengungkapkan peningkatan signifikan dalam keterampilan proses sains siswa, dengan skor rata-rata 72,08. Tes t-sampel tunggal menunjukkan nilai signifikan 0,000, mengindikasikan efek positif aplikasi Phyphox. Temuan ini menyarankan potensi pergeseran menuju lingkungan pembelajaran yang terintegrasi teknologi dalam pendidikan fisika, meningkatkan keterlibatan dan pemahaman siswa. Meskipun menjanjikan, penelitian ini mengakui keterbatasannya dalam ukuran sampel dan konteks, menyoroti kebutuhan penelitian lebih lanjut di berbagai lingkungan pendidikan. Studi ini berkontribusi pada tubuh penelitian yang berkembang yang mendukung

ARTICLE HISTORY
Received: November 28, 2023
Accepted: January 11, 2024

KEYWORDS:

Phyphox Application, Science Process Skills, Experiment

KATA KUNCI:

Aplikasi Phyphox, Keterampilan Proses Sains, Eksperimen

* Corresponding author:
Andio Calen Evains, Prodi Pendidikan FIsika, Universitas Islam Negeri Alauddin Makassar, Indonesia)
✉ calenevainsandio@gmail.com

alat digital dalam pendidikan, dengan tujuan mempersiapkan siswa untuk dunia yang berteknologi maju.

A. Introduction

Integrating technology in education, particularly in physics, represents a crucial paradigm shift for global society, the academic discipline, and addressing specific educational challenges. Modern education demands innovative approaches to leverage technology in learning processes, significantly impacting students' comprehension and engagement [1], [2]. In physics education, experiments are pivotal, offering hands-on experiences to solidify theoretical knowledge [1], [3]. However, the effective execution of these experiments faces substantial challenges, primarily due to resource limitations, highlighting a significant problem in educational institutions worldwide.

Previous research has extensively documented the effectiveness of smartphone technology in enhancing physics education. Studies show that smartphones, with various sensors, can effectively replace traditional laboratory equipment, providing an accessible and innovative approach to conducting experiments [4], [5]. This has been further corroborated by research demonstrating the positive impact of smartphone-based learning tools on students' theoretical and practical understanding of physics [6], [7].

Continuing this trend, other studies have explored the role of smartphones in facilitating experimental physics, emphasizing their cost-effectiveness and educational utility. For instance, smartphone sensors have been used to teach concepts such as kinematics, dynamics, and wave optics, with significant improvements in students' cognitive abilities and learning motivation [8]–[10]. These findings underscore the versatility of smartphones as practical educational tools in various physics topics.

In addition to cognitive gains, using smartphones in physics education has been linked to improved student engagement and independent learning. Projects like Smartphysicslab and studies on collaborative game models using smartphone sensors have revealed significant enhancements in students' test results and autonomous learning capabilities [11], [12]. These studies highlight the potential of integrating technology with traditional teaching methods to foster a more engaging and effective learning environment.

The literature also reveals a growing trend in using smartphones to address the challenges of online and offline physics teaching. The development of physics e-modules and learning applications for smartphones demonstrates their effectiveness in enhancing digital literacy, understanding of physics concepts, and independent learning [13]–[15]. This trend points to the significant role of smartphones in reshaping the educational landscape, particularly in physics.

Despite these advancements, existing literature presents gaps and limitations that this study aims to address. Most research focuses on the general effectiveness of smartphone technology in physics education, with less emphasis on specific educational contexts or student groups. There is a need to investigate the impact of smartphone-based experiments on students' scientific process skills in a more targeted setting, such as SMA Negeri 1 Wajo [16], [17]. Additionally, while the potential of smartphones to enhance learning motivation and theoretical understanding is recognized, their impact on the development of scientific process skills in physics requires further exploration.

This study, therefore, focuses on evaluating the effectiveness of using smartphones as measuring tools in physics experiments, assisted by the Phyphox app, at SMA Negeri 1 Wajo. It aims to assess the impact on the scientific process skills of grade XI students and explore the potential influence of this approach on their learning experiences. By addressing the identified gaps, this research contributes to a deeper understanding of technology integration in physics education and its potential to enhance scientific literacy. The findings are expected to offer valuable insights into the practical application of smartphone technology in educational settings and its effectiveness in improving students' scientific process skills. Furthermore, this study will contribute to the ongoing discourse on innovative teaching methods in physics education, particularly in resource-constrained environments. The potential implications of this research extend beyond SMA Negeri 1 Wajo, providing a framework for implementing technology-enhanced physics education in similar contexts globally.

B. Method

The current study, conducted in Physics Education, adopted a Pre-Experimental Design (non-design) as its research methodology. The specific design used was the One-Shot Case Study, which involves applying an experimental treatment to a single group or class and observing the outcomes [20]. This approach is tailored to the objectives of this study, focusing on the application and impact of the Phyphox application in a classroom setting [18], [19]. The research was executed at SMAN 1 Wajo, aligning with the Physics class schedule for 11th-grade students during the odd semester of the 2023/2024 academic year. The target population consisted of all 122 students in the 11th grade, distributed across three classes.

For the sampling process, 24 students from one class were selected using purposive sampling. This technique was necessary due to the constraints related to permissions from the school authority, which prevented the formation of new experimental or control groups [21], [22]. In terms of data collection instruments, the study employed science process skill tests, lesson plans (RPP), and student worksheets

(LKPD) [23]. The data analysis involved a combination of descriptive analysis and inferential statistical analysis, which included conducting Basic Assumption Tests (Uji Prasyarat) and hypothesis testing [24], [25]. The selection of these analytical methods and instruments was driven by the study's objective to comprehensively understand the impact of the Phyphox application in a real-world educational setting. To ensure the reliability and validity of the study, careful consideration was given to the methodology, instrument selection, and data analysis techniques, albeit within the limitations of the chosen design and sampling method.

C. Result and Discussion

Based on the results of the science process skills test of the eleventh-grade students at SMA Negeri 1 Wajo on the topic of Harmonic Vibrations, the data on the science process skills of the students are obtained as presented in the frequency distribution table in Table 1 below:

Table 1: Frequency distribution of science process skills test scores for class XI students at SMA Negeri 1 Wajo

No	Grade	Fi
1	90	2
2	80	4
3	75	5
4	70	7
5	65	4
6	55	1
7	50	1
Total		24

The data in Table 1 above is presented as a reference in processing descriptive analysis. The results of the analysis can be seen in the Table 2 below:

Table 2: Results of the descriptive analysis of the science process skills of class XI students at SMA Negeri 1 Wajo

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance
					Statistic	Std. Error		
KPS	24	40	50	90	72,08	1,878	9,198	84,601
Valid N (listwise)	24							

Based on Table 2 above, it can be explained that the maximum score is the highest science process skill score obtained by students after taking the post-test with a score of 90, while the minimum score is the lowest score obtained by students with a score of 50. The average or mean is the sum of all values in a distribution divided by the number of cases; in this case, the average value obtained is 72.08.

Apart from that, the standard deviation, variance, and expected error values are also visible. Standard deviation is a measure that describes the level of spread of data from an average value of 9.18. Furthermore, variance is a handy measure of diversity, or variance is the calculated average of the squared deviations of each data from the calculated average. Above, you can see a significant variance value of 84.60. The standard error estimates the standard deviation of a sample particular value used to calculate an estimator value, which can be seen above the value of 1.87. The table of results for the science process skills test results can be seen in Figure 1.

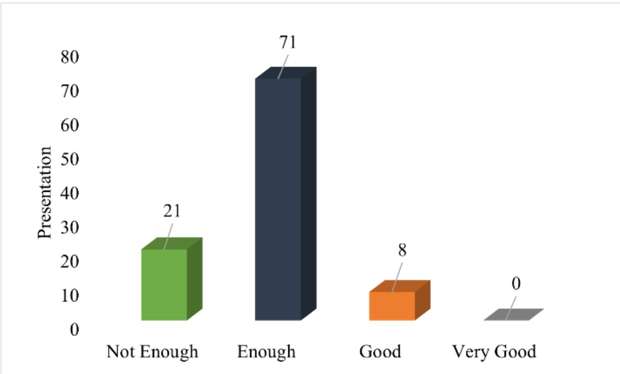

Figure 3: Results of the Science Process Skills Test

Figure 1 above shows the categorization of students' scores, where most students' science process skills scores are in a suitable category with a value range of 62.51 – 87.50.

Hypothesis testing aims to prove the hypothesis presented in this research. The hypothesis test used in this research is the *one-sample test*, at a significant level of $\alpha = 0.05$, which was analyzed using the application SPSS version 27 for Windows. The results obtained at the significance level of 0.000 are more minor than 0.005, so it can be said that H_0 was rejected and H_1 was accepted, i.e., There is an effect of using the Phyphox application on the science process skills of class XI students at SMA Negeri 1 Wajo, namely in the excellent category. These results can be shown in Table 3 below:

Table 3: One-Sample Test

	T	df	Sig. (2-tailed)	Mean Difference	Test Value = 65 95% Confidence Interval of the Difference Lower	Upper
KPS	3,773	23	,001	7,083	3,20	10,97

A study is said to have a proven hypothesis if the significant value is smaller than 0.05, where H_1 is accepted, and H_0 is rejected. Based on Table 4, it is proven that the critical value is $0.000 \leq 0.05$. This means that the application Phyphox application influences the science process skills of class XI students at SMA Negeri 1 Wajo.

This study examined the impact of using smartphones as measuring tools in physics experiments on students' science process skills. Previous studies have highlighted the effectiveness of smartphone-based tools and methods in teaching physics and chemistry, enhancing both theoretical understanding and practical skills [4], [5]. Integrating technology in physics education, primarily through applications like Phyphox, has shown promising results in various learning environments [6], [26].

The results from the eleventh-grade students at SMA Negeri 1 Wajo demonstrate a significant improvement in science process skills. Most students scored in the 'good' category, with a mean score of 72.08 and a high maximum score of 90 (see Table 1 and Table 3). This outcome indicates a notable enhancement in students' abilities to apply scientific concepts practically, aligning with the growing trend of integrating smartphones in science education [7], [27].

Comparing these results with previous studies, the effective use of smartphone applications in physics education is evident. Similar experiments have improved students' conceptual understanding and cognitive abilities [11], [12]. However, this study's findings provide a more focused insight into the role of smartphones in enhancing specific science process skills, reinforcing the conclusions drawn by earlier research [28], [29].

The improvement in science process skills can be attributed to smartphone-based experiments' interactive and engaging nature. This approach allows students to observe and measure physical phenomena directly, bridging the gap between theoretical knowledge and practical application [10], [30]. However, caution must be exercised in interpreting these results. The dependence on smartphone literacy highlights a potential limitation, as high smartphone usage does not necessarily correlate with improved science literacy [16], [31]. Furthermore, the diversity in students' backgrounds and prior exposure to technology might influence their ability to effectively utilize these tools in an educational context [14], [15].

The implications of these findings are significant for the future of physics education. They suggest a shift towards more technologically integrated learning environments, where smartphones can enhance student engagement and understanding [13], [32]. This study supports the growing body of research advocating for the incorporation of digital tools in education, emphasizing their potential to improve learning outcomes and prepare students for a technologically advanced world [33]–[35].

D. Conclusion

In this study, we aimed to assess the effectiveness of smartphones as measurement tools in physics laboratories, mainly focusing on the science process skills of Class XI students at SMA Negeri 1 Wajo using the Phyphox application. Our findings revealed a significant improvement in students' science process skills, with an average score of 72.08 and a notable positive impact indicated by the one-sample t-test considerable value of 0.000. These results underscore the potential of integrating technology, like smartphones and applications like Phyphox, to enhance student engagement and understanding in physics education. While the study presents a promising outlook for using digital tools in educational settings, it also acknowledges limitations such as the specific sample and context. It emphasizes the need for further research across diverse educational settings to validate these findings and explore the long-term effects of technology integration in education. This study aligns with current trends in academic research advocating for incorporating digital tools to improve learning outcomes and prepare students for a technologically advanced world, thereby suggesting a paradigm shift in physics education towards more technologically integrated learning environments.

Acknowledgments

Thank you. I express my gratitude to all aspects that supported this research. First of all, I would like to thank Mrs. Santih Anggereni, S.Si., M.Pd, as the first supervisor, and express my gratitude to Mr. Muh. Said L, S.Si., M.Pd, as the second supervisor, for all the support and guidance throughout this research.

References

[1] M. Nuh, “Lampiran Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 104 Tahun 2014 Tentang Penilaian Hasil Belajar oleh Pendidik pada Pendidikan Dasar dan Pendidikan Menengah,” 2014.

[2] T. Novita Sonia, “Prosiding Seminar Nasional Teknologi Pendidikan Pascasarjana UNIMED,” 2012, pp. 191–199.

[3] N. Cholid, *Pengembangan Multimedia Pembelajaran*. CV Presisi Cipta Media, 2021.

[4] V. B. dos Santos, W. M. S. de Oliveira, J. P. B. de Almeida, M. V. Foguel, W. T. Suarez, and J. L. de Oliveira, “RGB-LED-Photometer and The Digital Image-Based Method Using a Smartphone for Chemistry and Physics Teaching,” *Quim. Nova*, vol. 46, no. 9, pp. 924–930, 2023, doi: 10.21577/0100-4042.20230065.

[5] A. Delvert, P. Panizza, and L. Courbin, “Measuring the viscosity of air with soapy water, a smartphone, a funnel, and a hose: An experiment for undergraduate physics students,” *Am. J. Phys.*, vol. 90, no. 1, pp. 64–70, 2022, doi: 10.1119/10.0006881.
[6] E. A. Maldonado, P. Ramírez, and W. R. Avendaño, “Smartphone and teamwork as a methodological tool for teaching and learning physics,” in *J. Phys. Conf. Ser.*, Valbuena O., Gelvez-Almeida E., and Nino E.D.V., Eds., IOP Publishing Ltd, 2022. Doi: 10.1088/1742-6596/2159/1/012020.
[7] A. Y. Nuryantini, M. R. Adawiyah, and M. A. Ariayuda, “The application of smartphone sensors to promote cognitive abilities easier and more effective physics learning,” in *J. Phys. Conf. Ser.*, IOP Publishing Ltd, 2021. doi: 10.1088/1742-6596/2098/1/012023.
[8] A. Khandelwal *et al.*, “Modern Physics Demonstrations with DIY Smartphone Spectrometers,” *Phys. Educ.*, vol. 4, no. 1, 2022, doi: 10.1142/S2661339522500032.
[9] O. Kuzyk, O. Dan’kiv, and I. Stolyarchuk, “Using the Wolfram Mathematica Software Product and the Smartphone to Determine Kinematic Quantities in Physics Laboratory Workshop,” in *Int. Sci. Tech. Conf. Computer. Sci. Inf. Tech.*, Institute of Electrical and Electronics Engineers Inc., 2023. doi: 10.1109/CSIT61576.2023.10324257.
[10] A. Kaps and F. Stallmach, “Development and didactic analysis of smartphone-based experimental exercises for the smart physics lab,” *Phys. Educ.*, vol. 57, no. 4, 2022, doi: 10.1088/1361-6552/ac68c0.
[11] P. Cicuta and G. Organtini, “Smartphysicslab: a creative Physics Laboratory using Arduino and smartphones,” in *J. Phys. Conf. Ser.*, Borg Marks J., Galea P., Gatt S., and Sands D., Eds., Institute of Physics, 2022. doi: 10.1088/1742-6596/2297/1/012013.
[12] M. Del Carmen Córdova Martínez and R. A. Zapana, “Collaborative game model for teaching physics using smartphone sensors,” in *ACM Int. Conf. Proc. Ser.*, Association for Computing Machinery, 2020, pp. 6–10. doi: 10.1145/3439147.3439153.
[13] R. Rizal, D. Rusdiana, W. Setiawan, and P. Siahaan, “Learning Management System Supported Smartphone (LMS3): Online Learning Application in Physics for School Course to Enhance Digital Literacy of Pre-Service Physics Teachers,” *J. Technol. Sci. Educ.*, vol. 12, no. 1, pp. 191–203, 2022, doi: 10.3926/JOTSE.1049.
[14] S. Saputra, “Developing subject-specific pedagogy (Ssp) of local wisdom ‘meriam bambu’ physics learning media assisted with smartphones to improved self-regulated learning in senior high school,” *Int. J. Sci. Technol. Res.*, vol. 9, no. 2, pp. 305–310, 2020.
[15] Z. Lv and Z.-Y. Peng, “Using a smartphone to teach physics experiment online and offline,” in *ACM Int. Conf. Proc. Ser.*, Association for Computing Machinery, 2021, pp. 76–81. doi: 10.1145/3474995.3475009.
[16] H. Putranta and H. Setiyatna, “The effect of smartphones usability on high school students’ science literacy ability in physics learning,” *European J Educ. Res.*, vol. 10, no. 3, pp. 1383–1396, 2021, doi: 10.12973/EU-JER.10.3.1383.

[17] A. Abdulayeva, “Using Smartphones in Home Education to Perform Physics Lab,” in *SIST - IEEE Int. Conf. Smart Inf. Syst. Technol.*, Institute of Electrical and Electronics Engineers Inc., 2021. doi: 10.1109/SIST50301.2021.9465968.

[18] M. Suardi, *Belajar dan Pembelajaran*. Deepublish, 2018.

[19] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Alfabeta, 2019.

[20] I. E. Khuluqo, *Modul Pembelajaran Manajemen Pengembangan Kurikulum*. CV Feniks Muda Sejahtera, 2022.

[21] Purwanto, *Metodologi Penelitian Kuantitatif untuk Psikologi dan Pendidikan*. Pustaka Pelajar Offset, 2012.

[22] S. Supardi, “Populasi dan Sampel Penelitian,” *Unisia*, vol. 13, no. 17, pp. 100–108, 1993.

[23] Sudirman, “Penerapan Pembelajaran Berbasis Alat Peraga Sederhana Terhadap Keterampilan Proses Sains Peserta Didik Kelas X,” *[Journal Name]*, vol. 7, no. 1, pp. 85–91, 2019.

[24] Sudjana, *Metode Statitik*. Tarsito, 2005.

[25] Sahlan and Widodo, “Pengaruh Model Ekperiental Learning Berbantuan Aplikasi Phyphox terhadap Motivasi Belajar Fisika di SMA,” *Jurnal Pendidikan Fisika Dan Terapannya*, vol. 4, p. 76, 2020.

[26] I. Kartika, “Smartphones physics comics application based on children’s character education,” in *AIP Conf. Proc.*, Saregar A., Umam R., Syazali M., and Putra F.G., Eds., American Institute of Physics Inc., 2023. doi: 10.1063/5.0141301.

[27] S. A. Hootman and C. Pickett, “A Semester-Long Study of Magnetic Fields Using Smartphones to Engage Non-Physics Majors,” *Phys. Teach.*, vol. 59, no. 2, pp. 108–110, 2021, doi: 10.1119/10.0003463.

[28] M. Colţ, C. Radu, O. Toma, C. Miron, and V.-A. Antohe, “Integrating smartphone and hands-on activities to real experiments in physics,” *Rom. Rep. Phys.*, vol. 72, no. 4, pp. 1–12, 2020.

[29] L. Sukariasih, L. Sahara, L. Hariroh, and S. Fayanto, “Studies using smartphone sensor for physics learning,” *Int. J. Sci. Technol. Res.*, vol. 8, no. 10, pp. 862–870, 2019.

[30] I. Averina and E. Yusuf, “Physics laboratory with a smartphone: Sound and light,” in *J. Phys. Conf. Ser.*, Wibowo F.C., Costu B., Arymbekov B., Taufik null, Rahman N.A., Attom M., Muliyati D., Suhendar H., Sanjaya L.A., and Fitri U.R., Eds., Institute of Physics, 2023. doi: 10.1088/1742-6596/2596/1/012062.

[31] M. E. Wahyuni and D. Sulisworo, “The utilization of sensors on smartphone to determine the coefficient of kinetic friction with the inclined plane in supporting physics learning,” *Int. J. Adv. Sci. Technol.*, vol. 29, no. 5, pp. 5345–5352, 2020.

[32] C. Radu, O. Toma, Ș. Antohe, V.-A. Antohe, and C. Miron, “Physics Classes Enhanced by Smartphone Experiments,” *Rom. Rep. Phys.*, vol. 74, no. 4, 2022,

[33] R. Rizal, D. Rusdiana, W. Setiawan, and P. Siahaan, “Students perception of learning management system supported smartphone: Satisfaction analysis in online physics learning,” *J. Pendidikan IPA Indones.*, vol. 9, no. 4, pp. 600–610, 2020, doi: 10.15294/jpii.v9i4.25363.

[34] M. F. Apriani, “Preliminary study of physics e-module development using research-based learning model through smartphone to support digital learning in the revolutionary 4.0,” in *J. Phys. Conf. Ser.*, IOP Publishing Ltd, 2021. doi: 10.1088/1742-6596/1876/1/012042.

[35] E. Maryam and A. Fahrudin, “The Development of Media Application Physics Learning Based Smartphone and Its Effects on Students’ Learning Outcomes on Kinematics Materials,” in *J. Phys. Conf. Ser.*, Mujiarto null, Simarmata J., Sukono null, and Rahim R., Eds., Institute of Physics Publishing, 2019. doi: 10.1088/1742-6596/1179/1/012080.