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THE EFFECTIVENESS OF INQUIRY-BASED LEARNING IN PROXIMITY SENSOR PRACTICUM TO IMPROVE STUDENT UNDERSTANDING

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ABSTRACT

Laboratory practicum is essential for understanding abstract concepts, and the Inquiry Based Learning model is often applied in this context. This study aims to measure the level of effectiveness of implementing inquiry based learning in an electronics practicum on analog proximity sensor material towards improving student concept understanding. This study uses a quantitative approach with a One-group pretest-posttest design involving 27 3rd-semester students from the Physics Department of UIN Sunan Gunung Djati Bandung. Data were analyzed using the Shapiro-Wilk normality test, hypothesis testing (paired t-test), and N-Gain analysis. The results showed that the pre-test (Sig. 0.054) and post-test (Sig. 0.089) data were normally distributed. The t-test showed a very significant difference (Sig. 0.000) between the pre-test (46.29) and post-test (73.70) mean scores. Despite a significant increase, the N-Gain Percent analysis showed an average effectiveness of 51.93%, which falls into the "Less Effective" category. There was a high disparity in results, where 37% of students were still "Not Effective". Factors such as the diversity of students' prior knowledge, material complexity, and guidance effectiveness were identified as causes for the non-optimal effectiveness. This study concludes that inquiry based learning needs to be integrated with differentiated learning.)

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1. INTRODUCTION

Laboratory practicums are designed to provide students with experiential learning opportunities, facilitating the comprehension of abstract concepts taught in classroom theory courses. This pedagogical approach enables students to not only commit the theoretical concepts taught in class to memory but also to acquire a more profound understanding through laboratory practicums (Satria & Devi, 2023). In the context of laboratory practical activities, particularly within the domain of physics, there is a clear synergy with the inquiry-based learning model. This pedagogical approach places significant emphasis on the formulation of questions, the execution of experiments, and the undertaking of systematic observation (Indah & Farida, 2024). The inquiry-based learning method is predicated on the premise that students will develop a more profound comprehension of the concepts with which they are engaged. The inquiry-based learning method has been demonstrated to exert a significant positive impact on learning outcomes, despite the challenges encountered in its implementation (Ambokari & Yermalinda, 2024).

In the domain of physics, particularly in the realm of electronics, a sensor is delineated as a component that discerns alterations in the value of a physical quantity and transcribes the measurement into a discernible signal for a recording instrument (Satria & Devi, 2023). A proximity sensor is a component that has the capacity to detect objects in its vicinity (Aribowo et al., 2021). The sensor utilises an electromagnetic field to detect objects in its vicinity.

A plethora of studies have corroborated the favourable impact of inquiry-based learning in the context of science education. The efficacy of inquiry-based learning in enhancing comprehension and academic performance has been extensively documented (Panjaitan, 2020). In the specific context of practical work, Rachmawaty et al. (2021) found that inquiry-based learning in practical work successfully improved science process skills. Despite the evidence from earlier studies (e.g., Rachmawaty et al., 2021; Panjaitan, 2020) that inquiry-based learning exerts a favourable effect on science process skills and conceptual understanding in general, there are research gaps that require attention. To date, there has been a paucity of research specifically measuring the level of effectiveness of the application of inquiry-based learning in the context of electronics practicums, especially those involving sensor material using analog components.

This study builds on Rachmawaty et al., 2021, which measured critical thinking skills, but shifts to measuring conceptual understanding. In contrast to the conclusions of their research, which suggested that inquiry-based learning is influential or superior, this study will assess the efficacy of this inquiry-based learning model in enhancing conceptual understanding in proximity sensor practicums. The present study is expected to determine the level of effectiveness of inquiry-based learning in proximity sensor practicums in improving the conceptual understanding of third-semester physics students quantitatively.

2. METHOD

The research was conducted in the physics department of the Faculty of Science and Technology, UIN Sunan Gunung Djati Bandung, in the third semester electronics practicum class. The students were divided into nine groups, with each group consisting of three to four students. The practicum was conducted in a guided inquiry manner with the objective of assembling electronic components in a dotmetric PCB to create a proximity sensor circuit to detect objects in front of it. The experimental setup incorporated an infrared proximity sensor, which provided the input to the system. An operational amplifier (OPAMP) integrated circuit (IC) was then utilised to convert the analog signal from the sensor into a digital signal with a low or high intensity. This converted signal was then employed to trigger the LED and buzzer as outputs.

This research was conducted by applying a quantitative approach to analyse the effect of a treatment on the same group through measurements before and after the practicum treatment (Mariati, 2018). The experimental design employed a one-group pretest-posttest paradigm, which was divided into three stages. The first stage involved the implementation of the inquiry-based learning model through a proximity sensor practicum. The third stage constituted the posttest, the purpose of which was to ascertain the changes that had occurred. The design is appropriate for the measurement of treatment-induced changes without the need for a control group. As posited by Sugiyono (2022), the design is illustrated in Table 1 below:

Location:
P1: Pre-test of student learning outcomes
X: Treatment/Intervention (Sensor Proximity Practicum)
P2: Post-test of student learning outcomes

Assisted by SPSS 27 software, the test results will be tested for normality, hypotheses, and analysed using N-Gain to determine the effectiveness of this practicum.

The number of students who underwent testing was less than fifty. Due to the limited sample size, normality testing was conducted utilising the Shapiro-Wilk method (Ahadi & Zain, 2023), with a decision value of sig > 0.05 for normally distributed data and sig < 0.05 for non-normally distributed data (Sugiyono, 2022).

In the event that the results of the normality test yield a normal distribution, a hypothesis test (i.e. a t-test) is then conducted, based on the following hypothesis:

It was determined that a significance level of 0.05 was met, indicating that there was no statistically significant difference in the learning outcomes of students before and after participating in a proximity sensor practicum that employed inquiry-based learning.

The null hypothesis, H0, is that there is no difference in students' learning outcomes before and after participating in a proximity sensor practicum using inquiry-based learning. The alternative hypothesis, Ha, is that there is a difference in students' learning outcomes before and after participating in a proximity sensor practicum using inquiry-based learning. The significance level is set at 0.05.

To conclude the study, an N-Gain test is administered in order to ascertain the effectiveness of the learning method in improving students' understanding (Hake, 1998). According to Hake (1998), N-Gain is defined as the ratio between the actual average gain and the maximum possible average gain.

The N-Gain equation is a commonly utilised tool in this field (Sukarelawa, 2024).

$$g = \frac{(Skor\ Posttest - Skor\ Pretest)}{(Skor\ maksimal - Skor\ Prertest)}$$

The effectiveness of this method is measured using normalised gain criteria.

Table 1. Table 1. N-Gain Values and Interpretation

Gain Value	Interpretation
0,70 ≤ g ≤ 1,00	High
0,30 ≤ g ≤ 0,70	Moderate
0,00 ≤ g ≤ 0,30	Low
g = 0,00	No Increase
-1,00 ≤ g ≤ 0,00	Decrease occurred

Source (Sukarelawa, 2024)

The percentage interpretation of N-Gain score effectiveness is detailed in the following table:

Table 2. N-Gain Values and Interpretation

Persentage (%)	Interpretation
<40	Ineffective
40-55	Less Effective
56-75	Moderately Effective
>76	Effective

Source (Febrinita, 2022)

3. RESULT AND DISCUSSION

The results of the pretest and posttest scores are displayed in Table 3. These scores were used to ascertain whether there was an increase in students' understanding after participating in the proximity sensor practicum using the inquiry-based learning method..

Table 3. Student Pre-test and Post-test Scores

Student ID a	Pemahaman Mahsiswa		ID Mahsiswa	Pemahaman Mahsiswa	
	Pre-Test	Post-Test		Pre-Test	Post-Test
M_1	40	60	M_{15}	50	60
M_2	50	80	M_{16}	50	60

Student ID a	Pemahaman Mahsiswa		ID Mahsiswa	Pemahaman Mahsiswa	
	Pre-Test	Post-Test		Pre-Test	Post-Test
M_3	30	70	M_{17}	40	60
M_4	40	60	M_{18}	40	60
M_5	50	60	M_{19}	40	80
M_6	70	80	M_{20}	70	80
M_7	40	80	M_{21}	60	100
M_8	70	90	M_{22}	30	40
M_9	40	70	M_{23}	30	80
M_{10}	50	80	M_{24}	10	50
M_{11}	60	100	M_{25}	50	70
M_{12}	40	90	M_{26}	50	60
M_{13}	50	100	M_{27}	60	90
M_{14}	40	80			

Eleven students scored below 50 in the pre-test, indicating that they did not understand most of the practical material. Six students scored above 50, suggesting they understood the material prior to the practical session. The remaining students were considered to have grasped some of the practical content. The post-test scores showed different results: only one student scored below 50, indicating that they still did not understand most of the practical material; only one student scored 50, indicating that they understood some of the practical material. Meanwhile, the remaining 25 students scored above 50, indicating that they had almost all understood the practical material after participating in the session.
The pre-test and post-test scores clearly show that the students' understanding improved greatly after participating in the practical session. Next, a normality test was conducted to determine whether the results were normally distributed. These results will then be used in the next step.

Tabel 4. Uji Normalitas dengan metode *Shapiro-wilk*

Test Type	Statistic	df	Sig.
Pre-Test	0,925	27	0,054
Post-Test	0,934	27	0,089

The results of the normality test for this study are shown in Table 4. The significance values obtained for the pre-test and post-test were 0.054 and 0.089, respectively. As both values are greater than 0.05, it can be concluded that the pre- and post-test data are normally distributed (Sugiyono, 2022). Furthermore, the data are suitable for analysis using a paired sample t-test, which is a type of parametric statistical testing.
To determine whether there was a significant difference between the two groups of data in this study, a t-test was performed. A Paired Samples t-test analysis was performed using the SPSS 27 application, with data obtained from the same group before and after the practicum. A summary of the statistics from both datasets is presented in Table 4.

Tabel 5. Ringkasan data statistik nilai *pre-test* dan *post-test*

		Rerata	N	Std. Deviation	Std. Error Mean
Pair 1	**Post_Test**	73,7037	27	15,72557	3,02639
	Pre_Test	46,2963	27	13,62920	2,62294

Students' scores increased significantly after participating in the practicum, rising from an average of 46.29 to 73.70. The pre-test and post-test standard deviations were 13.69 and 15.72, respectively. These results demonstrate that students' understanding of proximity sensors improved after taking part in the practicum using the inquiry-based learning model.

Tabel 6. Korelasi Kedua Sampel

		N	Korelasi	Sig.
Pair 1	**Post_Test & Pre_Test**	27	0,551	0,003

Table 6 shows a correlation value of 0.055, which is a positive value indicating that students who scored high on the pre-test also scored high on the post-test. The significance value obtained is 0.003. A significance value < 0.05 indicates that the correlation value is statistically significant. This proves that the pre-test and post-test scores were not obtained by chance, but through the practical activities carried out (Sugiyono, 2022).

Tabel 7. Hasil Uji-T Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Rerata	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Post_Test - Pre_Test	27,40741	14,03090	2,70025	21,85697	32,95785	10,150	26	,000

The N-Gain Percent test results show that the average increase in student learning outcomes is 51.93%. The analysis also includes a 95% confidence interval for the average, ranging from 41.63% (lower bound) to 62.23% (upper bound). This interval indicates that the actual population N-Gain average is 95% likely to be within these two values.

One interesting finding of this study concerns the interpretation of the N-Gain results. Although the increase in understanding was statistically significant (based on the t-test), the average N-Gain percentage achieved (51.94%) is categorised as 'Less Effective' (see Table 2). According to the original criteria (Hake, 1998), this score would be categorised as 'medium-g'. In many studies on the implementation of inquiry-based learning, N-Gain scores in the medium category (0.30 g to 0.70 g) are common. This demonstrates that, while the model has succeeded in producing good results, it has not yet reached an optimal level of effectiveness.

Several factors may have contributed to this suboptimal effectiveness. The most crucial of these is the students' prior knowledge (Purwasih, 2015). The research data shows that pre-test scores varied greatly, ranging from 10 to 70. This wide variation indicates the diversity of students' prior knowledge. Students with high prior knowledge tend to benefit more from the inquiry-based learning model than those with low prior knowledge (Suwaji et al., 2019), and prior knowledge significantly influences the learning outcomes achieved by students in the inquiry model.

The second factor is the complexity of the material. Material that integrates analogue sensor (infrared) concepts with IC op-amp functions as a digital signal comparator is highly abstract. Implementing inquiry-based learning with conceptually complex physics or electronics material is known to present challenges and require higher cognitive readiness from students (Sitanggang & Sirait, 2015).

The third factor is the effectiveness of guidance. In guided inquiry, as in the present study, the lecturer's role as a facilitator, providing timely assistance, is pivotal for success (Rohmatus Syafi'ah & Rahyu Setiani, 2024). Students with low N-Gain, who are likely to have lower initial abilities, require more intensive guidance to close the gap in their understanding (Amir et al., 2023; Sulistiyono, 2020). As the effectiveness of guidance may differ between groups, this can lead to varying results.

Tabel 9. Hasil Uji *N-Gain*

ID Mahasiswa	Pre-Test	Post-Test	N Gain Skor	N Gain %	Kriteria Efektivitas
M_1	40	60	0.33	33.33	Tidak Efektif
M_2	50	80	0.60	60.00	Cukup Efektif
M_3	30	70	0.57	57.14	Cukup Efektif
M_4	40	60	0.33	33.33	Tidak Efektif
M_5	50	60	0.20	20.00	Tidak Efektif
M_6	70	80	0.33	33.33	Tidak Efektif
M_7	40	80	0.67	66.67	Cukup Efektif
M_8	70	90	0.67	66.67	Cukup Efektif
M_9	40	70	0.50	50.00	Kurang Efektif

ID Mahasiswa	Pre-Test	Post-Test	N Gain Skor	N Gain %	Kriteria Efektivitas
M_{10}	50	80	0.60	60.00	Cukup Efektif
M_{11}	60	100	1.00	100.00	Efektif
M_{12}	40	90	0.83	83.33	Efektif
M_{13}	50	100	1.00	100.00	Efektif
M_{14}	40	80	0.67	66.67	Cukup Efektif
M_{15}	50	60	0.20	20.00	Tidak Efektif
M_{16}	50	60	0.20	20.00	Tidak Efektif
M_{17}	40	60	0.33	33.33	Tidak Efektif
M_{18}	40	60	0.33	33.33	Tidak Efektif
M_{19}	40	80	0.67	66.67	Cukup Efektif
M_{20}	70	80	0.33	33.33	Tidak Efektif
M_{21}	60	100	1.00	100.00	Efektif
M_{22}	30	40	0.14	14.29	Tidak Efektif
M_{23}	30	80	0.71	71.43	Cukup Efektif
M_{24}	10	50	0.44	44.44	Kurang Efektif
M_{25}	50	70	0.40	40.00	Kurang Efektif
M_{26}	50	60	0.20	20.00	Tidak Efektif
M_{27}	60	90	0.75	75.00	Efektif

The research data revealed that the effectiveness of inquiry-based learning (IBL) was not optimal, as evidenced by significant disparities in learning outcomes among students. Analysis of N-Gain values shows that of the 27 students, 10 (around 37%) are still in the "Not Effective" category. Meanwhile, only 5 students (around 18.5%) achieved the "Effective" category. This significant gap in achievement indicates that, although IBL has the potential to enhance understanding, its impact is not felt equally by all learners (Hidayat et al., 2023).

This disparity reflects the complex interplay between students' initial abilities and the difficulty of the material, which is not adequately addressed by the implemented guidance strategies. Bimbingan yang bersifat "satu ukuran untuk semua" (one-size-fits-all) dalam pengaturan IBL seringkali gagal mengakomodasi kebutuhan belajar yang beragam dari setiap individu. Penelitian Tomlinson (2017) menyoroti pentingnya merespons keberagaman peserta didik dalam hal kesiapan, minat, dan profil belajar. Therefore, a rigid approach can exacerbate the achievement gap, where high-ability students further excel, while those with lower initial abilities find it increasingly challenging to catch up.

To address this challenge, this study highlights that the implementation of IBL requires careful monitoring and flexible adjustments. The strategic solution offered is to integrate the principles of differentiated instruction into the IBL framework. Tomlinson (2017) mendefinisikan pembelajaran berdiferensiasi sebagai suatu proses sistematis untuk merancang pengalaman belajar yang mempertimbangkan variasi kebutuhan individu mahasiswa. This integration is intended to ensure that all students, regardless of their starting point, can meaningfully engage and achieve their learning objectives.According to Tomlinson (2017), differentiated instruction is a systematic process of designing learning experiences that cater for the varying needs of individual students. The aim of this approach is to ensure that all students, regardless of their starting point, can engage meaningfully with the learning objectives and achieve them.

This integration can be realised through providing different guidance and scaffolding according to the group's needs or the students' initial ability level. For instance, groups with lower initial abilities could be given more structured guidance and concrete examples, whereas more advanced groups could be presented with open and complex problems as challenges. Hidayat et al. (2023) concluded in their study that providing differentiated guidance during the inquiry process can significantly improve learning effectiveness in a more optimal and equitable manner. This approach enables each student to work within their own zone of proximal development. While this finding does not negate the advantages of active learning paradigms such as IBL, it does highlight that average effects can hide inequality at an individual level. Lazonder & Harmsen's (2016) meta-analysis acknowledges that, although IBL is generally effective, the magnitude of its impact depends heavily on the level of guidance provided. Without appropriate guidance, less prepared students may experience confusion and cognitive overload, which ultimately hinders learning.

Therefore, the main conclusion of this study is that the success of IBL lies not only in the application of the method itself, but also in educators' ability to respond to students' diverse needs throughout the process. In practice, this means that educators need to act as diagnostic facilitators who continuously monitor progress and provide differentiated resources and support. As previous studies have suggested, the future of IBL lies in its synergy with other pedagogical frameworks, such as differentiated learning, to ensure that all students have the opportunity to achieve high levels of learning effectiveness (Tomlinson, 2017; Hidayat et al., 2023).

However, this study also raises an important point of criticism. The average benefit of active learning does not necessarily guarantee fairness or effectiveness for every individual in the classroom. Its implementation requires careful monitoring and flexibility. Without adjustments that consider the diversity of students' learning styles, knowledge and readiness levels, this approach risks only benefiting those who already have strong initial capital. Therefore, the ultimate goal should be to ensure that all students can achieve higher levels of understanding and competence, not just to raise average scores.

4. CONCLUSION

The findings of the study indicate that the implementation of the inquiry-based learning model in proximity sensor practicums has yielded a statistically significant enhancement in conceptual understanding among students. This hypothesis is evidenced by the t-test results (Sig. 0.000) and an increase in the average score from 46.29 (pre-test) to 73.70 (post-test). However, the N-Gain Percent analysis revealed that the effectiveness of this inquiry-based learning model was only 51.93%, which falls into the Less Effective category. This suboptimal effectiveness was due to several factors, including the diversity of students' initial abilities, the level of complexity of the practicum material, and the effectiveness of guidance in guided inquiry, which was likely uneven. This is evidenced by the significant discrepancy in the results, wherein 37% of the students (10 out of 27) were still classified as Ineffective. Consequently, this study proposes that the integration of inquiry-based learning with differentiated learning strategies in future implementations should be considered, with a view to more effectively and equitably managing student ability diversity.

REFERENCES

[1] Ahadi, G. D. & Zain, N. N. L. E. (2023). Pemeriksaan Uji Kenormalan dengan Kolmogorov-Smirnov, Anderson-Darling dan Shapiro-Wilk. *EIGEN MATHEMATICS JOURNAL*. https://doi.org/10.29303/emj.v6i1.131

[2] Ambokari, W. & Yermalinda, D. (2024). Studi Literatur Model Pembelajaran Inkuiri terhadap Hasil Belajar Siswa. *Prosiding Ilmu Kependidikan*, *1*(1). https://propend.id/index.php/propend

[3] Amir, N., Pallenari, M. & Syutin, N. (2023). Peningkatan Kemandirian Belajar Siswa Melalui Model Pembelajaran Inquiri Berbantuan Media Produk Berdiferensiasi di SMP Negeri 5 Sinjai. *Jurnal Pemikiran Dan Pengembangan Pembelajaran*, *5*(2).

[4] Aribowo, D., Desmira, D., Ekawati, R. & Rahmah, N. (2021). SISTEM PERANCANGAN CONVEYOR MENGGUNAKAN SENSOR PROXIMITY PR18-8DN PADA WOOD SANDING MACHINE. *EDSUAINTEK: Jurnal Pendidikan, Sains Dan Teknologi*, *8*(1). https://doi.org/10.47668/edusaintek.v8i1.146

[5] Febrinita, F. (2022). EFEKTIVITAS PENGGUNAAN MODUL TERHADAP HASIL BELAJAR MATEMATIKA KOMPUTASI PADA MAHASISWA TEKNIK INFORMATIKA. In *Jurnal Pendidikan Matematika* (Vol. 5, Issue 1).

[6] Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, *66*(1), 64–74. https://doi.org/10.1119/1.18809

[7] Hidayat, S. T., Istyowati, A. & Pratiwi, H. Y. (2023). Penerapan Inkuiri Terbimbing dan Pembelajaran Berdiferensiasi dalam Mengembangkan Kemampuan Berpikir Kritis. *Jurnal Pembelajaran, Bimbingan, Dan Pengelolaan Pendidikan*, *3*(9). https://doi.org/10.17977/um065v3i92023p787-802

[8] Indah, R. P. & Farida, A. (2024). Analisis Perbedaan Pemahaman Materi terhadap Kemampuan Berpikir Mahasiswa dengan Model Inquiry dan Discovery. *Jurnal Ilmiah Ilmu Pendidikan*, *7*(5), 5113. http://Jiip.stkipyapisdompu.ac.id

[9] Mariati, M. (2018). Penerapan Alat Evaluasi Pembelajaran Bertingkat Berdasarkan Taksonomi Bloom Dalam Meningkatkan Kemampuan Berfikir Mahasiswa. *LIABILITIES (JURNAL PENDIDIKAN AKUNTANSI)*, *1*(2). https://doi.org/10.30596/liabilities.v1i2.2328

[10] Panjaitan, B. (2020). Pengembangan Bahan Ajar Fisika pada Materi Bio Mekanika Berbasis Inkuiri. *Jurnal Ilmiah Binalita Sudama Medan*. http://ojs.bsm.ac.id/index.php/bsmejurnal/article/view/15

[11] Purwasih, R. (2015). Peningkatan Kemampuan Pemahaman Matematis Dan Self Confidence Siswa MTs Di Kota Cimahi Melalui Model Pembelajaran Inkuiri Terbimbing. *Jurnal Ilmiah STKIP Siliwangi Bandung*, *9*(1).

[12] Rachmawaty, D. U., Wijaya, A. R. & Dasna, I. W. (2021). Pengaruh Praktikum Inkuiri Terbimbing terhadap Kemampuan Berpikir Kritis Siswa dengan Kemampuan Awal Berbeda. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *6*(7), 1032. https://doi.org/10.17977/jptpp.v6i7.14911

[13] Rohmatus Syafi'ah & Rahyu Setiani. (2024). Efektivitas Perangkat Pembelajaran IPA SMP Berbasis Model Pembelajaran Inkuiri Terbimbing untuk Melatihkan Keterampilan Proses Sains Siswa. *JURNAL PENDIDIKAN MIPA*, *14*(3), 652–659. https://doi.org/10.37630/jpm.v14i3.1636

[14] Satria, R. P. & Devi, V. M. (2023). PENGEMBANGAN ALAT PRAKTIKUM FISIKA BERBASIS SENSOR ULTRASONIK BERBANTUAN APLIKASI DELPHI. *ORBITA: Jurnal Pendidikan Dan Ilmu Fisika*, *9*(1). https://doi.org/10.31764/orbita.v9i1.14621

[15] Sitanggang, J. & Sirait, M. (2015). PENGARUH MODEL PEMBELAJARAN KOOPERATIF TIPE TEAM ASISSTED INDIVIDUALIZATION (TAI) BERBANTU MACROMEDIA FLASH TERHADAP HASIL BELAJAR SISWA. *Jurnal Penelitian Bidang Pendidikan*, *21*(1).

[16] Sugiyono. (2022). Metode penelitian pendidikan pendekatan kuantitatif, kualitatif dan R&D. *Jurnal Ilmu Dan Riset*.

[17] Sukarelawa, I. ; I. T. K. ; A. S. M. A. (2024). *N-gain vs stacking : analisis perubahan abilitas peserta didik dalam desain one group pretest-posttest*. Suryacahya.

[18] Sulistiyono, S. (2020). EFEKTIVITAS MODEL PEMBELAJARAN INKUIRI TERBIMBING TERHADAP KETERAMPILAN PROSES SAINS DAN PEMAHAMAN KONSEP FISIKA SISWA MA RIYADHUS SOLIHIN. *Jurnal Pendidikan Fisika Undiksha*, *10*(2). https://doi.org/10.23887/jjpf.v10i2.27826

[19] Suwaji, Syaiful & Efendi, M. H. E. (2019). Pengaruh Model Learning Cycle 5E dan Model Two Stay Two Stray Ditinjau Dari Kemampuan Awal terhadap Hasil Belajar IPA Siswa. *Edu-Sains*, *8*(1).

[20] Tomlinson, C. A. (2017). How to Differentiate Instruction in Academically Diverse Classrooms. *DIFFERENTIATE INSTRUCTION : In Academically Diverse Classooms*.