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The Influence of Problem Based Learning Models on Cognitive Learning Outcomes and Scientific Attitudes of High School Students on Thermochemical Subject

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Abstract: This study seeks to ascertain whether there are notable disparities in cognitive learning outcomes and scientific attitudes among high school students in both the experimental and control groups regarding thermochemical topics. Additionally, it aims to outline the cognitive learning outcomes profile in the experimental group and evaluate the scientific attitude profile of students in the same group concerning thermochemical concepts. This research is using quantitative research method. The population in this study were five high schools in Sleman Regency, Ngaglik Region. The sample used was SMA 2 Ngaglik in class XI Science. The research employed both non-test methods, such as questionnaires, and test-based approaches, using multiple-choice questions, for data collection. Non-parametric analysis was utilized for data analysis. The findings indicated that there were no significant variances in cognitive learning achievements and scientific attitudes among high school students in both the experimental and control groups regarding thermochemical topics. Moreover, the learning outcomes profile in classes implementing the Problem Based Learning model and scientific approach was rated as very good, while the scientific attitude profile in these classes was deemed adequate across all aspects.

Keywords: Learning outcomes; Problem based learning; Scientific attitude.

Introduction

Chemistry is a necessary subject for student's educational enrichment in this century (Haetami et al., 2023). Chemistry is a group of natural sciences which are considered as a process of scientific activity to discover or perfection knowledge and the products or result of the form of facts, concepts, principles, laws and theories (Gani et al., 2022). Chemistry is a scientific discipline characterized by its abstract and complex nature, so it requires a comprehensive understanding (Damsi & Suyanto, 2023). Therefore, chemistry is a scientific discipline that requires a substantial capacity for reasoning and understanding, which is closely related to three different dimensions: macroscopic, microscopic, and symbolic (Hawa & Louise, 2023). Chemistry learning explains more about a phenomenon (Fahmina et al., 2019). Chemistry learning is part of natural science learning which study facts that occur in nature (Majid & Rohaeti, 2018).

Chemistry has many abstract and complex concepts, but unfortunately many students have difficulty understanding chemical concepts and experience misconceptions. Chemistry subject are theoretical and practical which require high-level thinking skills (Dewi et al., 2019). This causes chemistry to often be seen as a difficult subject and results in students becoming less involved in the learning process.

Students often perceive chemistry as a challenging subject to grasp (Unaida et al., 2023). A notable issue in chemistry education is the limited engagement of students in the learning process. They continue to struggle with comprehending chemistry concepts, particularly in calculations. This shows that student learning outcomes are still low (Lestari et al., 2022). As a result, students encounter challenges in their learning

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journey and often make errors in comprehending chemistry topics. One such example is the study of thermochemistry (Tarawi et al., 2020).

This assertion is corroborated by the presence of numerous challenges and misunderstandings among students, as documented in various chemical education journals, suggesting the inherent difficulty of this subject matter (Anwar et al., 2023). Zakiyah et al., (2018) said that the complexity in comprehending thermochemistry can be attributed to students' insufficient grasp of stoichiometry, which serves as foundational knowledge. The intricacies of thermochemical topics deemed challenging incorporate: 1) comprehension of system, surroundings, reaction heat, and enthalpy; 2) grasping the notion of standard enthalpy change; 3) performing calculations related to enthalpy change in reactions; and 4) applying stoichiometry concepts in thermochemistry (Mukhlisa et al., 2021). Insights gleaned from interviews with chemistry educators, specifically in thermochemistry, it is evident that the academic achievements of some students in this domain are below satisfactory levels. An assessment of student learning outcomes was undertaken to assess the depth of students' understanding of thermochemical principles.

Learning outcomes is a tool used as a benchmark that will guide students towards the expected results that have been designed. Learning outcomes represent the anticipated achievements following the completion of the learning process. They represent an essential standard by which to assess the effectiveness of the learning process (Mahajan & Singh, 2017). By delineating specific expectations, learning outcomes facilitate a clearer comprehension of the learning trajectory (Prøitz, 2010). These outcomes denote the ultimate accomplishments attained by students upon concluding the learning process (Firmansyah, 2015). Learning outcomes as the evidence of change to determine whether or not they have succeeded in achieving learning objectives (Sabatini et al., 2022). Learning outcomes encompass a range of abilities, including cognitive, affective, and psychomotor skills (Retno et al., 2020).

Hidayaty et al., (2022) said that the significance of learning outcomes in the educational process has been highlighted. These outcomes serve as valuable indicators for teachers, offering insights into students' progress towards their learning objectives during instructional activities. Given the myriad of factors impacting classroom learning outcomes, it becomes the responsibility of educators to enhance student achievement (Muslim et al., 2022). One of the learning outcomes in the attitude aspect is scientific attitude. A scientific attitude can help students to understand the concepts given in class which will bring student learning outcomes in a more positive direction (Supardi et al, 2019). Scientific attitude is an individual's tendency to act to solve problems through scientific steps (Murningsih et al., 2016).

The cultivation of a scientific attitude holds significant importance for every student, particularly during the learning journey, as it fosters heightened motivation and enthusiasm for engaging in scientific inquiry. This, in turn, sparks a profound curiosity in exploring natural phenomena (Afifah et al., 2022). Student involvement can increase if students can develop their scientific attitudes. A scientific attitude that contains character education values that can maximize students becoming better in the learning process. A scientific attitude is open to thoughts and ideas, building collaboration with knowledge between teachers and students and between students and students to exchange ideas during the learning process (Lengkong et al, 2020).

Teachers often narrow their focus in chemistry education solely to product acquisition, overlooking crucial elements such as cultivating a scientific mindset (Suciati et al., 2014). However, it's essential to recognize that in the learning journey, conceptual growth goes hand in hand with nurturing a scientific attitude. The essence of learning is formed through a combination of scientific outcomes, methodologies, and attitudes. Increasing scientific attitudes is also very important to get better learning outcomes (Putri et al., 2017). In practice, educators have yet to fully integrate a scientific mindset into the educational process, resulting in students' limited adoption of such attitudes. The deficiency in students' scientific attitudes can be attributed to inadequate teaching methods and uninspiring instructional approaches, leading to decreased motivation and engagement in learning activities (Supiah & Andriani, 2020).

Addressing these challenges necessitates the adoption of achievement-oriented learning approaches, which can be facilitated through problem-based learning models derived from real-world contexts or students' own experiences. This approach empowers students to actively engage in their learning journey, promoting direct involvement and participation. By emphasizing experiential learning, where students learn by doing, this method proves to be more effective, enabling students to confront and overcome the challenges inherent in problem-solving (Supiah & Andriani, 2020).

Achieving success in the learning journey hinges on employing appropriate learning models (Jundu et al., 2020). By implementing the appropriate learning model, there is an expectation that it can enhance both students' scientific attitudes and their learning outcomes. The obstacle faced in the learning process is the discovery that chemistry learning only provides opportunities for students with high academic abilities to achieve satisfactory learning outcomes, while students with low academic abilities are left behind in their learning outcomes. In this case, there needs to be a strategy or model that has an influence on a student in the educational environment (Sulistyaningsih et al., 2021).

One of the instructional models suitable for chemistry education, particularly for fostering cognitive development, is Problem Based Learning (PBL). This model aligns with students' cognitive capacities and has the potential to effectively achieve this goal. Students can indirectly hone their abilities in being scientific, creative and systematic (Faqiroh, 2020).

Problem Based Learning (PBL) is an instructional approach offering unique avenues for self-directed and lifelong learning opportunities (Tosun & Senocak, 2013). It centers around authentic problem-solving tasks (Permata et al., 2022), embodying a constructive, collaborative, and context-driven educational activity (Goh & Yew, 2016). As an alternative educational model, PBL is particularly suitable for fostering students' problem-solving skills and comprehension (Yulia & Salirawati, 2023).

Problem Based Learning is primarily centered on engaging students in problem-solving activities, with the overarching goal of enhancing student learning outcomes. By employing Problem Based Learning (PBL), it is anticipated that students will be motivated to enhance their learning achievements, particularly in the study of thermochemical material within chemistry education (Sulistyaningsih et al., 2021).

Considering the preceding discussion, it is essential to conduct this study to determine the difference in learning outcomes and scientific attitude resulting from the utilization of problem-based learning. This is an important step to determine student learning outcomes, including scientific attitude.

Method

This study employs quantitative descriptive research methodology, specifically utilizing a cross-sectional survey approach. The research was conducted at SMA 2 Ngaglik Sleman using 2 classes totaling 70 class XI students as samples. The research carried out aims to analyzed and determine the profile of students' learning outcomes and scientific attitudes.

Throughout this study, data collection is conducted through the utilization of a scientific attitude questionnaire and multiple-choice assessments for learning outcomes. These instruments are employed to evaluate the learning outcomes and scientific attitudes of eleventh-grade students.

Result and Discussion

Research Implementation

This study was conducted at SMA Negeri 2 Ngaglik in September 2023, with the research implementation occurring in two phases, which are: learning activities and final data collection. The first stage of implementing learning activities is the implementation stage using the he experimental class utilized the Problem Based Learning (PBL) model, while the control class employed a scientific approach for implementation. The second stage is collecting final data. The activity carried out in this stage is giving a posttest on student learning outcomes. The research classes used in this research consist of two classes, namely class XI MIPA 3 and XI MIPA 4. The number of students in class XI MIPA 3 is 35 people and XI MIPA 4 is 35. XI IPA 3 as an experiment Class using PBL, while class XI MIPA 4 is a control class with a scientific approach. Each class receives thermochemical learning material. The posttest was carried out in the third week which was the last week of the research. The results of the research in the experimental class, 35 students participated in the posttest, achieving an average score of 88.3. Among them, 4 students scored above 70, 13 students scored above 80, and 18 students scored above 90. In contrast, in the control class, 35 students took the posttest, yielding an average score of 86.2. Within this group, 5 students scored above 70, 22 students scored above 80, and 8 students scored above 90.

Hypothesis Test Results

Normality Test

A normality assessment was performed on the posttest data of both the control and experimental groups. The outcomes of this assessment are displayed in Table 1, showcasing the normality test results for the posttest scores in each group.

Table 1. Normality Test Results on Learning Outcomes *Posttest* Data

Classes	Data	Statistic	Asymp. Sig	Explanation
Control Experiment	Posttest Posttest	0.55	0.92	Normal Distributed

According to Table 1, the Asymp. Sig value for the posttest learning outcomes in the control and experimental classes was 0.92 with a statistic of 0.55. It can be inferred that the data exhibits a normal distribution, as the Asymp. Sig value exceeds 0.05.

Homogeneity Test

A homogeneity test was conducted on the posttest data for both the control and experimental classes. The results of the homogeneity test for the posttest scores in both classes are presented in Table 2.

Table 2. Homogeneity Test Results on Learning Outcomes *Posttest* Data

Data	Significan Score	Explanation
Learning Outcomes	0.00	Not Homogen
Scientific Attitude	0.27	Homogen

From Table 2, it is evident that the significance value for the learning outcomes is 0.00, indicating that the data is not homogeneous as the value is below 0.05. Conversely, for scientific attitude, the significance value is 0.27, suggesting that the data is homogeneous since the value exceeds 0.05.

Hypothesis Testing

The outcome of the normality test yielded a value of 0.923, indicating that the data follows a normal distribution. However, the homogeneity test resulted in values of 0.000 for students' cognitive learning outcomes and 0.279 for students' scientific attitudes, suggesting that the data is not homogeneous. Consequently, hypothesis testing was conducted using non-parametric statistical methods, specifically the Kruskal-Wallis test, to account for the non-homogeneous data groups. Data analysis for this study was performed using SPSS 16 software.

Table 3 displays the outcomes of the Kruskal-Wallis test regarding the impact of the Problem Based Learning model on high school students' cognitive learning outcomes and scientific attitudes concerning thermochemical material.

Table 3. Kruskal Wallis Test Results Learning Outcomes and Scientific Attitudes

	Learning Outcomes	Scientific Attitude
Asymp. Sig	0.08	1.00

According to Table 3, the significance value for cognitive learning outcomes is 0.08. Therefore, it can be deduced that there is no discernible difference in cognitive learning outcomes between the Problem Based Learning class and the scientific approach class based on these findings. Additionally, the significance value for students' scientific attitudes is 1.00, which exceeds 0.05. Consequently, it can be inferred that there is no discrepancy in students' scientific attitudes between the Problem Based Learning class and the high school scientific approach class regarding thermochemical material, as indicated by these data.

The study's findings lead to the conclusion that the Problem Based Learning model does not influence cognitive learning outcomes or students' scientific attitudes, as there is no disparity observed in either learning outcomes or students' scientific attitudes.

Discussion

This study comprised two classes: one experimental class (XI MIPA 3) which adopted the Problem Based Learning (PBL) model, and one control class (XI MIPA 4) which followed a scientific approach. In each class, distinct learning processes were conducted: the experimental class was exposed to the Problem Based Learning model, while the control class underwent traditional scientific learning. Following the completion of learning activities, a Posttest was administered to assess student learning outcomes. The key disparity between the control and experimental classes lies in the instructional methodology: the control class adhered to a structured scientific approach learning plan, whereas the experimental class followed the framework of the Problem Based Learning (PBL) model, encompassing problem orientation, organizing students for observation, assisting with individual research, facilitating presentations, and analysing or evaluating the problem-solving process. Next, after getting scores from student learning outcomes, normality tests, homogeneity tests and non-parametric tests are carried out.

The normality test outcomes for both the control and experimental groups suggest that the data follows a normal distribution, with significance values of 0.92. Following this, the homogeneity test was performed, indicating that the data lacks homogeneity concerning cognitive learning outcomes (significance value: 0.00), whereas it demonstrates homogeneity regarding scientific attitudes (significance value: 0.27). Given the non-homogeneous nature of the data, a hypothesis test using non-parametric statistical analysis, specifically the Kruskal-Wallis test, was employed. The Kruskal-Wallis test results demonstrated no significant difference in the impact of the Problem Based Learning model on high school students' cognitive learning outcomes and scientific attitudes regarding thermochemical material.

Based on the hypothesis testing results, specifically the Kruskal-Wallis test for learning outcomes, a value of 0.08 was obtained, indicating a significance value greater than 0.05. Therefore, the null hypothesis (Ho) is accepted, suggesting that there is no significant disparity in cognitive learning outcomes attributed to the Problem Based Learning model in the context of thermochemical materials. Both the experimental and control classes exhibited very good cognitive learning outcomes. Similarly, for scientific attitudes, the test yielded a value of 1.00, with a significance value exceeding 0.05, leading to the acceptance of Ho

Therefore, it can be inferred that there is no significant distinction in students' scientific attitudes towards thermochemical material resulting from the Problem Based Learning model. Adequate scientific attitudes were observed in both the experimental and control classes. The breakdown of scientific attitude categories is presented in Table 4.

Table 4. Results of Scientific Attitude Categories for Experimental Class and Control Class

Aspects	Experiment Class	Control Class	Percentage (%) Experiment	Percentage (%) Control	Category
Curiosity	147.6	145.2	84.34	82.97	Adequate
Open Minded	145.2	146.4	82.97	83.66	Adequate
Critical Thinking	147.8	145.2	84.46	82.97	Adequate
Perseverance	144.2	146.4	82.40	83.66	Adequate
Teamwork	147.5	146	84.33	83.43	Adequate
Respect toward data/facts	144	143.3	82.29	81.90	Adequate
Average	146	145.4	83.46	83.10	Adequate

Based on table 4 it shows that the categories for each aspect in terms of scientific attitude are classified as adequate in both the experimental class and the control class. Experimental class on the curiosity aspect with scores of 147.6 and 84.34%, the open-minded aspect with scores of 145.2 and 82.97%, the critical thinking aspect with scores of 147.8 and 84.46%, the perseverance aspect with scores 144.2 and 82.40%, the cooperation aspect with a value of 147.5 and 84.33%, and the aspect of respect for data or facts with a value of 144 and 82.29%. The average value is 146 with a percentage of 83.46%. The results for the control class were in the curiosity aspect with scores of 145.2 and 82.97%, the open-minded aspect with scores of 146.4 and 83.66%, the critical thinking aspect with scores of 145.2 and 82.97%, the perseverance aspect with scores of 146.4 and 83.66%, the cooperation aspect with a value of 146 and 83.43%, and the aspect of respect for data or facts with a value of 143.3 and 81.90%. The average value is 145.4 with a percentage of 83.10%. The ability to have a good scientific attitude will lead to better learning activities and with these activities students will get better learning outcomes (Putri et al., 2017).

This study's findings indicate that the Problem Based Learning model does not influence the learning outcomes and scientific attitudes of high school students regarding thermochemical material. Implementing the Problem Based Learning model yields learning outcomes and scientific attitudes comparable to those observed in classes not utilizing this model. Both the problem-based learning model and the scientific approach share nearly identical syntax, exhibiting similarities in which the emphasis is placed on collaborative student efforts to tackle problem-solving within the learning process (Oktaviani et al., 2018).

The first syntax of Problem Based Learning is problem orientation and the syntax of the scientific approach is observing. Students are given examples of problems that exist in everyday life via video or directly. Student involvement in this step can help discover the fact that there is a relationship between the object being observed and the learning material being studied. The second syntax of Problem Based Learning is organizing students and the syntax of the scientific approach is asking questions. This step is related to discussions in class about information that is not yet understood regarding the problem. The learning outcomes in this step can be seen as to the types of questions that arise from students. The third syntax of Problem Based Learning is to help research and the syntax of the scientific approach is to collect information. In this step, students collect the information they have sought through class discussions and are assisted by the teacher as a facilitator for student learning references. The fourth syntax of Problem Based Learning is presenting results and the syntax of a scientific approach, namely processing or analyzing data. Students can analyze the results they have done and can compare them with the results of other students. The final syntax of Problem Based Learning is analyzing or evaluating problems and the syntax of the scientific approach is communicating. In this step, students can make conclusions verbally or with presentations in front of the class. This step can provide students with the opportunity to communicate the results of the learning process that has been carried out.

Figure 1. Thermochemical Learning Process

Figure 2. Teamwork Discussion

Conclusion

The outcomes of this research propose that employing the Problem Based Learning model yields equivalent cognitive learning outcomes in thermochemical material for both the experimental and control groups. Furthermore, there is no observable distinction in the scientific attitudes of students towards thermochemical material between the experimental and control groups. The learning outcomes profile indicates that the experimental class achieved an average score of 88.3, while the control class obtained an average score of 86.2, demonstrating high learning outcomes for both groups. In terms of scientific attitudes, the experimental class achieved an average score of 83.46% for each aspect, while the control class averaged 83.10%, suggesting adequate profiles for both groups.

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Author Contributions
This article was compiled by two individuals, namely N.A., the researcher, and E.R., the supervisor. All authors have reviewed and consented to the publication of the manuscript.

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The authors have no conflicts of interest to declare.

References

Afifah, S., Purnamawati, R. N., Aznam, N., Wilujeng, I., & Suyanta. (2022). Profile of Students' Scientific Attitudes Through Electronic Science Textbooks Based on Local Wisdom for Madura Salt Making. *Jurnal Penelitian Pendidikan IPA,* 8(2), 605-613. https://doi.org/10.29303/jppipa.v8i2.1192.

Anwar, S., Sumarna, O., & Mulyadi, A. (2023). Feasibility Analysis of Thermochemistry Senior High School Chemistry Textbook Based on Criteria of Four Steps Teaching Material Development Method. *Jurnal Penelitian Pendidikan IPA*, 9(3), 1394-1401. https://doi.org/10.29303/jppipa.v9i3.2770.

Damsi, M., & Suyanto, S. (2023). Systematic Literature Review: Multiple-tier Diagnostic Instrumens in Measuring Students Chemistry Misconceptions. *Jurnal Penelitian Pendidikan IPA,* 9(5), 8-21. https://doi.org/10.29303/jppipa.v9i5.2600

Dewi, R. K., Wardani, S., Wijayati, N., & Sumarni, W. (2019). Demand of ICT-based Chemistry Learning Media In The Disruptive Era. *International Journal of Evaluation and Research in Education (IJERE),* 8(2), 265-270. https://doi.org/10.11591/ijere.v8i2.17107.

Fahmina, S. S., Indriyanti, N. Y., Setyowati, W. A. E., Masykuri, M., & Yamtinah, S. (2019). Dimension o Chemical Literacy and its Influence in Chemistry Learning. *Journal of Physics:Conf. Series,* 1233(1), 1-8. https://doi.org/10.1088/1742-6596/1233/1/012026.

Faqiroh, B. Z. (2020). Problem-Based Learning Model for Junior High School in Indonesia (2010-2019). *Indonesian Journal of Curriculum and Education Technology Studies,* 8(1), 42-48. https://doi.org/10.15294/ijcets.v8i1.38264.

Firmansyah, D. (2015). Pengaruh Strategi Pembelajaran dan Minat Belajar terhadap Hasil Belajar Matematika. *Jurnal Pendidikan Unsika*, 3(1), 34-44. https://doi.org/10.35706/judika.v3i1.199.

Gani, A., Hanum, L., & Mahbengi, R. (2022). Student Learning Outcomes of Chemistry Education Undergraduate Program Through Online Mode. *Jurnal Pendidikan Kimia Indonesia,* 6(1), 1-10. https://doi.org/10.23887/jpk.v6i1.

Goh, K., & Yew, E. H. J. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education*, 2, 75-79. https://doi.org/10.1016/j.hpe.2016.01.004.

Haetami, A., Arwien, R. T., Marhadi, M. A., Rudi, L., & Arsyad, M. (2023). Increasing Literacy Ability in Chemistry on A Socio-Scientific Basis. *Jurnal Penelitian Pendidikan IPA*, 9(6), 154-161. https://doi.org/10.29303/jppipa.v9i6.3908.

Hawa, N. E. T., & Louise, I. S. Y. (2023). The Effect of the Guided Inquiry Learning Model with a Scientific Approach to Green Chemistry and Global Warming Material on Students Critical Thingking Ability and Learning Motivation. *Jurnal Penelitian Pendidikan IPA*, 9(12), 10853-10859. https://doi.org/10.29303/jppipa.v9i12.5955.

Hidayaty, A., Qurbaniah, M., & Setiadi, A. E. (2022). The Influence of Word Wall on Students' Interest and Learning Outcomes. *Jurnal Penelitian Ilmu Pendidikan,* 15(2), 211-223. https://doi.org/10.21831/jpipfip.v15i2.51691.

Jundu, R., Tuwa, P. H., & Seliman, R. (2020). Hasil Belajar IPA Siswa SD di Daerah Tertinggal dengan Penerapan Model Pembelajaran Inkuiri Terbimbing. *Scholaria: Jurnal Pendidikan dan Kebudayaan*, 10(2), 103-111. https://doi.org/10.24246/j.js.2020.v10.i2.p103-111.

Lengkong, M., Rampean, B., Rohaeti, E., & Septriwanto, J. (2020). How Can Open Inquiry Enhancing Students' Scientific Attitude Through Chemistry Learning. *Advances in Social Science, Education and Humanitities Research*, 528, 238-245. https://doi.org/10.2991/assehr.k.210305.035.

Lestari, P. N. S. S., Redhana, I. W., & Subagia, I. W. (2022). The Effect of Electronic Chemistry Books Based on Local Balinese Culture on Learning Outcomes of High School Students. *Jurnal Penelitian Pendidikan IPA,* 8(5), 2279-2285. https://doi.org/10.29303/jppipa.v8i5.1881.

Mahajan, M., & Singh, M. K. S. (2017). Importance and Benefits of Learning Outcames. *IOSR Journal Of Humanities And Social Science (IOSR-JHSS),* 22(3), 65-67. https://doi.org/10.9790/0837-2203056567.

Majid, A. N., & Rohaeti, E. (2018). The Effect of Context-Based Chemistry Leraning on Student Achievement and Attitude. *American Journal of Educational Research,* 6(6), 836-839. https://doi.org/10.12691/education-6-6-37.

Mukhlisa, R., Gani, A., Winarni, S., Khaldun, I., & Hanum, L. (2021). Independence of Learning and Achievement of Learners' Cognitive Abilities in Theermochemical Materials through the Application of Flipped Classroom. *Jurnal Penelitian Pendidikan IPA*, 7(4), 523-530. https://doi.org/10.29303/jppipa.v7i4.674.

Murningsih, I. M. T., Masykuri, M., & Mulyani, B. (2016). Penerapan Model Pembelajaran Inkuiri Terbimbing untuk Meningkatkan Sikap Ilmiah dan Prestasi Belajar Kimia Peserta Didik. *Jurnal Inovasi Pendidikan IPA*, 2(2), 177-189. https://doi.org/10.21831/jipi.v2i2.11196.

Muslim, F., Ekawarna., Ramalia., A., Wirayuda, R. P., & Chen, D. (2022). Learning Intensity and Visual Learning Style on Learning Outcomes. *Journal of Educational Research and Evaluation,* 6(2), 385-396. https://doi.org/10.23887/jere.v6i2.40312.

Oktaviani, B. A. Y., Mawardi., & Astuti, S. (2018). Perbedaan Model *Problem Based Learning* dan *Discovery Learning* Ditinjau Dari Hasil Belajar Matematika Siswa Kelas 4 SD. *Scholaria: Jurnal Pendidikan dan Kebudayaan,* 8(2), 132-141. https://doi.org/10.24246/j.js.2018.v8i2.p132-141.

Permata, S. A. I., Sunarno, W., & Harlita. (2022). The Effect of the Problem Based Learning and Double Loop Problem Solving Learning Models on Problem Solving Ability in Term of Creative Thinking on Environmental Pollution Material. *Jurnal Penelitian Pendidikan IPA*, 8(6), 1-7. https://doi.org/10.29303/jppipa.v8i6.1996.

Prøitz, T. S. (2010). Learning outcomes: What are they? Who defines them? When and where are they defined?. *Educ Asse Eval Acc*, 22, 119-137. https://doi.org/10.1007/s11092-010-9097-8.

Putri, A. T., Idrus, I., & Yennita, Y. (2017). Analisis Korelasi Sikap Ilmiah dan Hasil Belajar Kognitif Siswa melalui Model PBL. *Diklabio: Jurnal Pendidikan dan Pembelajaran Biologi,* 1(1), 1-9. https://doi.org/10.33369/diklabio.1.1.1-9.

Retno, S. P., Khoiri, N., & Norra, B. I. (2020). The Effectiveness of Cooperative Learning Model in the Type of *Numbered Heads Together* (NHT) Assisted with *Picture Puzzle* Media on Self-Efficacy and Student Learning Outcomes in the Coordination System Material. *Journal of Physics: Conference Series*, 1779(1), 1-8. https://doi.org/10.1088/1742-6596/1779/1/012058.

Sabatini, G., Mahulae, S., Anzelina, D., & Silaban, P. J. (2022). Upaya Meningkatkan Hasil Belajar Peserta Didik dengan Menggunakan Model *Discovery Learning*. *Jurnal PAJAR (Pendidikan dan Pengajaran)*, 6(1), 47-59. https://doi.org/10.33578/pjr.v6i1.8547.

Suciati, N. N. A., Aryana, I. B. P., & Setiawan, I. G. A. N. (2014). Pengaruh Model Pembelajaran Siklus Belajar Hipotetik-Deduktif dengan Setting 7E terhadap Hasil Belajar IPA Ditinjau dari Sikap Ilmiah Siswa SMP. *Jurnal Pendidikan dan Pembelajaran IPA Indonesia,* 4(1), 1-14.

Sulistyaningsih, T., Dirmanto, A., & Cahyono, E. (2021). The Effectiveness of Problem Based Learning on Acid-Base Materials of Improve Scientific Attitude and Creativity of SMA N 1 Comal Students. *Journal of Innovative Science Education*, 10(2), 193-198. https://doi.org/10.15294/jise.v10i2.

Supardi, R., Istiyono, E., & Setialaksana, W. (2019). Developing Scientific Attitudes Instrument of Students in Chemistry. *Journal of Physics: Conference Series,* 1233(1), 1-5. https://doi.org/10.1088/1742-6596/1233/1/012025.

Supiah, Y. L. I., & Andriani, R. (2020). Effect of Problem Based Learning Models on Students' Analytical Thinking Abilities and Scientific Attitudes in Chemistry. *Journal of Physics: Conference Series,* 1806(1), 2-6. https://doi.org/10.1088/1742-6596/1806/1/012190.

Tarawi, O., Noer, A. M., & Linda, R. (2020). The Development of Acid-Base E-Chemistry Magazine as Interactive Teaching Materials. *Journal of Physics: Conference Series*, 1440(1), 1-8. https://doi.org/101088/1742-6596/1440/1/012012.

Tosun, C., & Senocak, E. (2013). The Effect of Problem-Based Learning on Metacognitive awareness and attitudes toward chemistry of Prospective Teacher with Different Academic Backgrounds. *Australian Journal of Teacher Education,* 38(3), 61-73. https://doi.org/10.14221/ajte.2013v38n3.2.

Unaida, R., Lukman, I. R., Fakhrah., Zahara., & Sabrin, N. (2023). The Effect of Adversity Quotient on Chemistry Learing Outcomes in Chemistry Subjects in Lhokseumawe City. *Jurnal Penelitian Pendidikan IPA*, 9(1), 104-108. https://doi.org/10.29303/jppipa.v9i1.2339.

Yulia, Z., & Salirawati, D. (2023). The Effect of Problem Based Learning on Students' Critical Thinking

Ability and Scientific Attitude. *Jurnal Penelitian Pendidikan IPA*, 9(6), 4211-4217. https://doi.org/10.29303/jppipa.v9i6.3026.

Zakiyah, Z., Ibnu, S., & Subandi, S. (2018). Analisis Dampak Kesulitan Siswa pada Materi Stoikiometri terhadap Hasil Belajar Termokimia dan Upaya Menguranginya dengan Metode Pemecahan Masalah. *EduChemia (Jurnal Kimia Dan Pendidikan)*, 3(1), 119. https://doi.org/10.30870/educhemia.v3i1.1784.