

# Learning Styles to Support Mastery of Aromatic Hydrocarbon Material with a Problem-Based Learning Model

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**Abstract:** The characteristics of problem based learning are: problem posing; focuses on the interrelationships between disciplines; existence of authentic investigations; produce works and exhibit them; and cooperation in groups. The purpose of the research presentation in this article is to discuss learning styles supporting the mastery of Aromatic Hydrocarbons material with the Problem Based Learning Model. The results of the study found that the learning styles of mathematical logic, interpersonal, and intrapersonal support the mastery of Aromatic Hydrocarbons material. Study completeness in lectures on Aromatic Hydrocarbons material of 24% was achieved by students with very good criteria. The results of the presentation of research data can be concluded that learning styles with the same characteristics with problem based learning model can improve student learning outcomes.

**Keywords:** Aromatic Hydrocarbon; Learning Style; Problem Based Learning

## Introduction

In this education world, success people can be seen by their process of learning activities, so that learning activities can be measured through learning achievement (Sudarsana, 2016). Learning achievement of each person is in accordance with the level of success in studying subject matter which is expressed in the form of grades or report cards for each field of study after experiencing the teaching and learning process (Hamdani, 2017; Lubis et al., 2017)}. Apart from that, Firdianti (2018) explains that learning achievement is proof of learning success or a student's ability to carry out learning activities according to the weight he has achieved.

Students must continue to strive to improve their learning achievements, but students face many obstacles in their learning activities, so that the grades they get are sometimes low. This will affect their learning achievement. To overcome this low learning achievement, it is necessary to explore the factors that cause low learning achievement. It is hoped that by knowing the factors that influence learning

achievement, the problems faced by students in improving their learning achievement can be resolved (Oktariani, 2018).

The presentation of research results in this article aims to determine learning styles that support mastery learning of Aromatic Hydrocarbons using the Problem Based Learning (PBL) Model. One model of lectures designed to involve active students in lectures and can improve learning outcomes, namely Problem Based Learning (PBL). PBL is different from conventional lectures where students in their learning process work in teams in the process of solving problems together by collecting data and sharing information or ideas (Overton & Randles, 2015a). Problem solving requires students' high-level thinking skills. Higher-order thinking activities will result in deeper understanding and better application of knowledge (Zejnilić-Hajrić et al., 2015). In contrast to conventional lecture methods where teachers usually present information content with problems. Where this traditional method has a weakness, namely the lack of connection between the knowledge learned and practice in real life (Aidoo et al., 2016; Mutiah, 2021). In PBL, students must play a more

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active role, namely as highly motivated learners (Abanikannda, 2016). So that with PBL it will increase the desire of students to learn.

The characteristics covered in PBL include (1) problems are used as the beginning of learning; (2) problems challenge students to learn in new learning domains; (3) prioritizes self-directed learning; and (4) learning is collaborative, communicative and cooperative (Tabun et al., 2019). Problem Based Learning (PBL) is a learning model that directs students to have a desire to understand, learn good learning needs so they are willing to use and look for learning resources the best in order to solve the problems faced.

The six type of representative approaches to PBL are: 1) pure PBL is learning initiated by a need to solve a real world, ill structured problem, no lectures; 2) hybrid PBL is pure PBL supplemented with a few lectures; 3) anchored instruction is students possess basic content knowledge before engaging in the problem solving activities, which comprise the major portion of the course; 4) project-based learning is learning initiated by lecture or students possess basic content knowledge before engaging in the project; project activities comprise the major portion of the course; 5) case-based learning is learning initiated by lecture, accompanied with case analysis/study (using solved problem); 6) lecture-based with problem solving activities is learning initiated by and comprised with lectures, accompanied with a few problems for practice at the end of the course (Scholz & Anderson, 2018).

The teacher's role in PBL is very important, namely as a facilitator who will guide students through the different phases of the PBL process. The teacher ensures the involvement of all students in the lecture process where they can exchange information with their peers by projecting their own thoughts and commenting on each other's ideas. Teachers in PBL are also tasked with encouraging students to use logical thinking in solving given problems, so they can develop higher-order thinking skills. The teacher also encourages students to retrieve previous knowledge and discuss it with their group members (Abanikannda, 2016).

The success of students' cognitive achievements is also determined by their learning style. Learning style is a way of learning that is preferred by students. An appropriate learning style is the key to success for a student in learning. Therefore, in learning activities students really need to be assisted and directed to identify learning styles that suit themselves so that learning goals can be achieved effectively. This is the duty of a professional teacher where the teacher must understand the characteristics of a student, understand differences in potential, recognize variations in learning styles and treat each student as a unique and complete

person to achieve national education goals (Bire et al., 2014).

Every student has their own way of learning and understanding information. There are various ways, namely learning by listening, reading and discovering. The various ways students learn are referred to as learning styles which are influenced by experience, gender, ethnicity and specifically inherent in each individual (Nugraha, 2023).

In college one has different backgrounds, strengths and weaknesses, interests, ambitions, sense of responsibility, level of motivation and approach. This condition will encourage someone to have a characteristic learning style. Each learner will develop the most preferred learning style according to the experience he gets. The entire PBL course process helps students become independent. This article discusses the results of research on learning styles supporting the PBL Model in improving students' cognitive achievement.

## Method

This study used quasi experimental, design in this study can be seen in Figure 1.

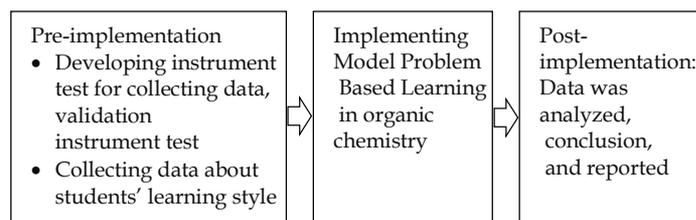


Figure 1. Research design in this study

Experimental research design in this study includes three steps: pre implementation, implementation, and post implementation. Pre implementation is done by the development of test instrument; also, the learning style of student is decided by using instruments that have already been developed by the previous researchers. After the implementation, the research was continued with data analysis, conclusion and research report.

Sample used in the research are students majoring in chemistry at UNESA who are taking Organic chemistry course, 1st semester batch 2022/2023, amounted to 50 students (25 students experiment class and 25 students control class). In order to take the organic chemistry course, students are required to have finished Basic chemistry I and Basic chemistry II course. Data analysis was done by qualitative descriptive approach to describe the result of the the students' concept development based on the learning result.

## Result and Discussion

The discussion of research results is mainly about the impact of implementing PBL on the achievement of learning outcomes in the cognitive domain of students. The achievement of learning outcomes in the cognitive domain of students can be seen in Figure 2.

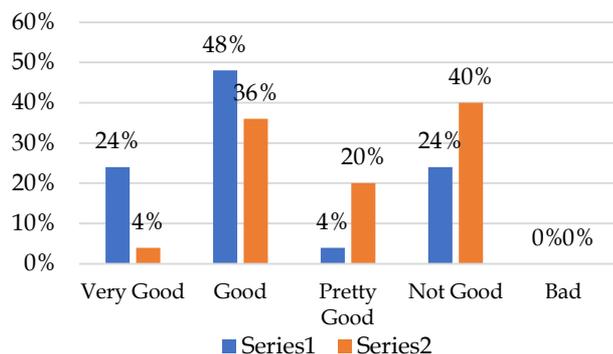


Figure 2. Student's Cognitive Achievement

The graph in Figure 2 describes the cognitive domain achievements of students in the experimental and control classes. The achievement of the cognitive domain of the experimental class (average 68.84) is better than the control class (average 61.16). These results are in line with research conducted by previous researchers, that the implementation of the PBL model can improve learning outcomes (Adisha & Rohaeti, 2024; Dalila et al., 2022; Overton & Randles, 2015b; Shamdas et al., 2024; Suyanta et al., 2019; Surya & Arty, 2020; Wahyu et al., 2018). In the experimental class, the PBL model lecture was implemented, while the control class used the conventional model. The successful implementation of PBL in the experimental class is in line with the research conducted by Zejnilagić-Hajrić et al. (2015) which states that activities in PBL are high-level thinking activities resulting in a deeper understanding and better application of knowledge.

The research that has been done is an application of the understanding of the synthesis of aromatic hydrocarbon compounds. This understanding is used to solve problems regarding the presence of benzene, chlorobenzene, and nitrobenzene compounds that have been buried in the Chemistry Department of Unesa for decades. Problem solving is associated with linking between disciplines. Linking between disciplines is done by linking material that has been obtained by students in lectures on Laboratory Organization, Economics, Entrepreneurship, Instrumental Chemistry, and Management.

Linking between disciplines in solving problems is a high-order thinking activity. These activities can motivate students to attend lectures. Student motivation

in participating in PBL lectures in this study is one of the success factors for students' cognitive achievement.

The success of students' cognitive achievements is also determined by their learning style. In college one has different backgrounds, strengths and weaknesses, interests, ambitions, sense of responsibility, level of motivation and approach. This condition will encourage someone to have a characteristic learning style. Each learner will develop the most preferred learning style according to the experience he gets.

In this study found learning styles supporting the PBL model in Table 1.

Table 1. Variety of Learner Learning Styles in the PBL Model

CRS	Learning Style	Cognitive Achievement
D	interpersonal	Very Good
I	Logika Matematika	Very Good
K	interpersonal	Very Good
R	Logika Matematika	Very Good
U	Intrapersonal	Very Good
B	Logika Matematika	Very Good
A	Visual spasial	Good
C	Linguistik	Good
E	Musikal	Good
F	Linguistik	Good
G	Intrapersonal	Good
H	Intrapersonal	Good
J	Naturalis	Good
M	Kinestetik	Good
N	Kinestetik	Good
O	Musikal,Naturalis	Good
S	Linguistik	Good
W	Linguistik	Good
X	Linguistik	Pretty Good
L	Intrapersonal	Not Good
P	Intrapersonal	Not Good
Q	Intrapersonal	Not Good
T	Kinestetik	Not Good
V	Kinestetik	Not Good
Y	interpersonal	Not Good

Table 1 describes the learning styles supporting the PBL Model. The focus of important information in Table 1 is on the learning styles of students in achieving very good and not good cognitive domains. The learning styles of students on cognitive achievement namely: a) very good: Mathematical Logic, Interpersonal and Intrapersonal; b) not good intrapersonal, kinesthetic, and interpersonal. Based on the research data in Table 1, it was found that the learning styles supporting the PBL Model were **Mathematical Logic, Interpersonal, and Intrapersonal**. These findings are based on the attainment of the cognitive domain with very good results. Students are declared complete when they achieve very good cognitive results. It is suitable with the reasearch of Nazilah & Mayarni (2023) which 1) PBL

has an effect on increasing students' interpersonal intelligence, and 2) PBL really makes the children easier to study about science.

In the Table 1, informs that there are six students who complete 3 students learning style of mathematical logic, 2 interpersonal, and 1 intrapersonal). Why is the achievement of cognitive outcomes not good, there are also interpersonal and intrapersonal learning styles? Code subject research (CSR) L, P, Q intrapersonal learning style and Y interpersonal learning style are students who experience problems in lectures. So that L, P, Q, and Y need to get help in solving their problems so they can follow lectures properly. This is in line with the opinion of Hidayat (2018) "There are no stupid students, there are only students who are ignorant and need the teacher's cognitive touch so that they become geniuses."

Why do only the learning styles of mathematical logic, interpersonal, intrapersonal support the PBL Model? Because the characteristics of mathematical logic, interpersonal, and intrapersonal learning styles are the same as the characteristics of PBL. The characteristics of PBL are: 1) filing a problem; 2) focusing on inter-disciplinary interrelationships; 3) authentic inquiry; 4) produce products or works and exhibit them; and 5) cooperation. The 3rd PBL characteristics are the same as the characteristics of the mathematical logic learning style. Characteristic 5) is the same as the characteristics of interpersonal learning styles. The entire process of PBL lectures provides students with experiences of becoming independent, this is in accordance with the characteristics of interpersonal learning styles. All results in this study strengthen the results of previous research conducted with Rinaningsih et al. (2018). The research results presented in this article as well as research on learning styles in 2018 broke the research conducted with Wahdaniyah & Rinaningsih (2022) get the results of research on all types of learning styles that experience an increase in cognitive development with 80% classical learning outcomes. Then, according Surur et al. (2020) we can conclude that there is a significant influence between the variables of learning strategies on students' problem solving abilities. It is supported by Edwards et al. (2019) that student preferred learning style is related to success in a learner centered problem-based learning formatted class and program, especially for physical therapy students. Apart from that, the result from Nugraha (2023) that learning achievement of students who study with the PBL learning model as group is higher than individually who get an average score of 82.00, also there is an interaction effect between learning models and learning styles on student learning achievement.

Learning outcomes using problem-based learning are better because this learning involves students

solving problems, by means of their creative ideas and ideas, so students do not easily forget the lessons they have learned (Anggraini et al., 2022). The Problem-Based Learning (PBL) model also has a positive effect on increasing students' critical thinking skills and identified that student learning styles influence learning outcomes. Some learning styles may be better suited to a PBL approach, while others are better suited to a conventional approach. Therefore, educators are expected to consider variations in student learning styles in designing effective learning (Islamiati et al., 2024). The Problem Based Learning model affects student learning outcomes by 95.00 and get average score of 82.83 also increasing motivation of students in PBL study which average value of 90.15 (Safitri et al., 2023).

## Conclusion

Each lecture model has characteristics that can be followed perfectly by students who have the same learning style characteristics as the lecture model it implements. Learning styles that have the same characteristics as the PBL Model, namely mathematical logic, interpersonal, and intrapersonal, so that the application of the PBL Model can support academic achievement.

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## Author Contributions

All authors had significant contributions in completing this manuscript

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## Conflicts of Interest

The authors declare no conflict of interest.

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