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# Implementation of Differentiated Learning in Terms of Teacher Beliefs and Science Literacy Dimensions

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**Abstract:** Differentiated learning is an effort to adapt the learning process in the classroom to the individual learning needs of each student. This research aimed to observe and describe the chemistry learning process with differentiated learning implemented in Malang City, Banyuasin Regency, and Palembang City. The research design utilized qualitative research methods, with a case study approach. The participants in this study were seven Chemistry Teachers from six different high schools spread across Palembang City, South Sumatra Province; Banyuasin Regency, South Sumatra Province; and Malang City, East Java Province. Data sources for this research included videos, recordings, evidence of learning, differentiated lesson plans, results of interviews, and field observations. The findings revealed that the pedagogical confidence of high school chemistry teachers in implementing differentiated learning and scientific literacy showed positive outcomes, despite being in the preliminary stages and not meeting all scientific literacy criteria. Additionally, the research indicated that high school chemistry teachers' beliefs regarding scientific literacy learning concepts and strategies fell between teacher-centric and student-centric approaches, categorized as transitional pedagogical beliefs. Furthermore, educational background factors, teaching experience in chemistry, and limited resources were identified as influencing factors on teachers' pedagogical beliefs, sometimes resulting in deviations from the planned learning process.

**Keywords**: Differentiated Learning; Teacher Beliefs; Dimensions of Scientific Literacy

## 1. INTRODUCTION

The Ministry of Education, Culture, Research and Technology (Kemendikbudristek) has launched an independent curriculum for schools by implementing independent learning. *Merdeka Belajar* essentially states that every student who learns is special and has specific abilities, so teachers must implement differentiated learning in teaching.

Curriculum changes focus on improving and revising the previous curriculum, namely by changing curriculum 13 to an independent curriculum. Education Teachers are the drivers of independent learning, educators play a role in designing strategies and learning methods based on the independent curriculum (*Kurikulum Merdeka*). Educators have difficulty implementing the independent curriculum because educators do not have experience with the concept of independent learning and there is a lack of reference materials for designing and implementing independent learning. Many chemistry teachers do not understand differentiated learning (Widarti et.al, 2024). As a teacher, it is important to be able to provide learning that encourages an effective learning process, so as to achieve success in the teaching process. Process Effective learning involves the use of appropriate methods with the problems faced. (Wahyuni, R. S, et.al., 2024).

Differentiated learning is an effort to adapt the learning process in the classroom to the individual learning needs of each student. Differentiated learning facilitates learners according to their learning needs (Heacox, 2012). The process of differentiating lessons is done to address the learning needs, styles or interests of each student. In simple terms, according to Alhafiz (2022), differentiated learning is a series of common sense decisions made by teachers that are oriented towards students' needs.

Differentiated learning is an adjustment of students' interests, learning profiles, and learning readiness in order to achieve improved learning outcomes. This is in line with previous findings which reported that the application of progressive differentiated learning strategies in mathematics learning can increase student learning activities from less active on initial reflection to active (Arifin et al., 2018; Haryanto et al., 2023). Not only that, another study explains the application of differentiated learning in professional conversation training conducted in Germany provides practical advantages in three aspects of conversational competence, namely: (a) building conversations, (b) advancing problem-solving, and (c) building positive interpersonal relationships. Differentiated learning is a very important way of thinking about teaching and learning in the 21st century (Ayub et al., 2021; Sumiarti et al., 2021).

Rahayu, S (2021) Developing the scientific literacy of Indonesian children is very important to do in this modern century. The reality shows that the scientific literacy of Indonesian children based on the PISA assessment is very low compared to other countries in the world. This will have an impact on the future of the Indonesian nation.

Students who are scientifically literate are the main goal of science education in various parts of the world, including in Indonesia. Teachers as a component of education providers are expected to be able to professionally direct learning in the classroom towards the realization of a scientifically literate society, namely a society that has knowledge and understands the scientific concepts and processes required for SRI RAHAYU is a Lecturer & Postgraduate Coordinator of the Chemistry Education Study Program, State University of Malang ( UM) 11 make decisions, be able to be aware of and participate actively in discussions and have a sense of concern and be able to make decisions regarding issues that occur in society and the world globally. In this regard, classroom learning needs to be designed in such a way that the components of content, process and scientific context are balanced. For example, including the context of socioscientific issues in science content, making the nature of science (NOS) explicit and emphasizing the cognitive process of critical thinking to optimize the scientific processes required for scientific literacy (Rahayu S, 2015).

Currently, all teachers in Indonesia must carry out differentiated learning according to the needs of students in independent learning. Chemistry teachers must also be able to do differentiated learning. In addition to implementing differentiated learning, chemistry teachers also need to strive to improve students' science literacy. Science literacy is the level of understanding of scientific and technological thinking needed to act as a member of modern industrial society (Bybee, 1997; Suwarno et al., 2021).

In an effort to improve the science literacy skills of their students, teachers need to conduct chemistry learning in accordance with learning objectives. Chemistry teachers in learning direct to achieve the dimensions of science literacy (1) Conten Knowledge (Content Knowledge) with the main element of ideas that explain a phenomenon. (2) Habit of minds is the competence to solve complex personal and global problems collaboratively by thinking critically, understanding concepts, and arguing scientifically (in the argument contains sufficient evidence and reasons to support claims) the realm of science literacy and inquiry skills (process). (3) Character and value that directs chemistry learning to achieve attitudinal, moral and responsibility goals. (4) Science as human endeavor (science as a human endeavor) is to understand the nature of science, and the relationship between science and society with the realm of science literacy: problem solving (5) Metacognition and self-direction (Metacognition and self-direction) is to explicitly understand one's own cognition and cognitive abilities to reflect the level of individual knowledge (Choi et al., 2011; Mardiati et al., 2022).

Scientific literacy skills also include abilities inquiry, critical insight, and integration explanations from various scientific disciplines and technology in aspects of real situations. Teachers need to train students to understand self-assessment. (Hasna,I., et.al.,2017)

The scientific literacy within PISA subsists of four aspects, namely contexts, scientific knowledge, competence, and attitude. The element of context is classified into three domains of personal, national, and global. Meanwhile, scientific knowledge is categorized into three parts of knowledge on content (information related to nature and human work, such as artefact and technology), procedural knowledge (insight on the creation of scientific ideas), and epistemic knowledge (knowledge on the basis of the scientific knowledge creation procedure and its usage justification). Competence represents the ability to explain and evaluate phenomena scientifically and design scientific inquiry and interpret data and evidence scientifically. Lastly, attitudes cover the manner toward science,

shown from the interest in science and technology, respecting scientific approach during the inquiry process, perception, and awareness on environmental issues. Accord (Djaen et.al, 2021)

Based on the research results, it shows the low level of teacher understanding. So efforts are needed to improve the quality of teaching, including increasing teachers' conceptual understanding, and analyzing chemistry teachers' understanding (Ilmah et.al.,2020)

Chemistry teachers also have their own beliefs in implementing differentiated learning to achieve learning objectives. Therefore, the purpose of this research is to see and describe the process of learning chemistry with differentiated learning applied in Malang city, Banyuasin district and Palembang city.

## 2. METHODS

This research design uses qualitative research methods, with the type of research being a case study. A case study is a study that is examined in depth with several data collection tools (observation, interviews, written documents) that can confirm each other within a limited system (DeBoer, 2000; Demir, 2021a). According to Yin (2008), a case study is a study that examines current phenomena in a real-life context, without clear boundaries between facts and context.

This research was conducted in 6 different high schools spread across Palembang city, South Sumatra Province, Banyuasin Regency, South Sumatra Province, and Malang City, East Java Province. This research was conducted in the even semester of the 2022-2023 academic year in high schools from January 25 to March 31, 2022. The participants of this research are seven Chemistry Teachers from 6 different high schools. The data sources of this research are videos, recordings, proof of learning, differentiated lesson plans, interview results and observations in the field. The data analysis technique of this research was carried out through several stages, namely description, coding, categorization and finally searching and investigating the results of the data obtained.

## 3. RESULTS AND DISCUSSION

The results of this study show that the concept of differentiated learning according to the participants is learning that pays attention to students' needs based on several aspects such as students' interests, students' potential, students' learning profiles/styles, learning readiness, and students' socio-economics.

This is like a statement from one of the participants who stated:

"*What I understand about differentiated learning is eeeh grouping student learning needs based on interests before we assess student learning needs based on interests and fulfillment. For example, before we teach in groups of students we make observations, for example, there are students who like music and then there are students who are slow in capturing calculations but in theory they are smart so we group them with students who are less smart so they need each other to be crossed like that. Then this differentiated learning is very good in my opinion because if a new person knows it, it feels difficult but after we live it, it's even fun because of what So we know the quality and needs of the students needed so that we can apply lessons for various kinds of learning according to what students want like that and also later students who are less in the eyes in certain fields will be covered by students who are less in the eyes. Sometimes the students who are lacking are good at theory, for example, I am teaching chemistry lessons for chemistry lessons, later the students are good at learning, for example, the periodic system, for example in class 10, well, if the smart student is maybe he is less happy with numbers in theory lessons like that, so there is something to give like that*"

From the statement above, it is known that in differentiated learning, Chemistry teachers must first understand the learning needs of each student to be able to adjust the learning process. In terms of adjustment, teachers can see it from the interests of each student. Herwina, (2021) states that differentiated learning is an effort to adjust the classroom learning process to meet each student's individual learning needs. The adjustments in question are related to interests, learning profiles, student readiness in order to achieve improved learning outcomes.

Chemistry teachers also believe that differentiated learning is very good and suitable to be implemented for students. Differentiated learning helps teachers to understand students' qualities and needs for the Chemistry learning process.

Differentiated learning aims to be able to accommodate the diversity of needs possessed by students so that later Chemistry teachers can adjust the needs of each individual in the classroom, in this case students.

There are various types of differentiation components that teachers can use in the learning process, namely content differentiation, process differentiation and product differentiation. According to Putri et al., differentiation learning strategy is divided into three components: content, process, and product. Content differentiation is a form of independent learning implementation in which the learning method provides material to students based on their skills, learning profiles, and knowledge. Meanwhile, process differentiation is how students process ideas, information, and materials that have been obtained. How students interact with the material and how these interactions become part of determining students' learning choices. And finally product differentiation, product differentiation is how students show what they have learned. From the results of interviews in this study, it is known that not all Chemistry teachers use these three components of differentiated learning, what they use most often is product differentiation, as stated by one respondent.

"*Differentiation of process, content and product is indeed ideally we do all. But if we do all of that, it takes tremendous time, so the differentiation that I often use is usually done according to the potential of the child, namely the product. Yes, I do the process automatically, the process remains yes, if the content, yes, of course, the content must get all*"

From the statement above, it is known that Chemistry teachers experience limited time to be able to implement all three components of differentiated learning so they can only choose and implement one of the differentiation components.

In addition, in implementing differentiated learning, Chemistry teachers need to conduct diagnostics or analysis first to be able to map students' learning needs. Diagnostics is an assessment that is carried out specifically to identify student competencies, strengths, weaknesses, so that learning can be designed according to student competencies and conditions (Demir, 2021b; Fitzgerald et al., 2013; Gray, 2020).

In conducting diagnostics of students, Chemistry teachers will understand how the learning style of each student is in the form of visual, audiotory, or kinestic. By knowing students' learning styles, teachers will easily map and fulfill students' learning needs.

Every student has a different learning style, Chemistry teachers need to understand how students can understand learning easily through their learning style. Learning style is a way of how students absorb learning material. The learning style approach is generally divided into three aspects, namely visual, auditory and kinesthetic. Visual style focuses on learning styles when students see learning with image media. The auditory style focuses on something that can be heard. While the kinesthetic learning style focuses on moving, touching, and working where students learn by prioritizing their feelings and physical movements (Heacox, 2012; Lumpe et al., 2000; Perumal et al., 2022).

The results of this study also show that the concept of chemical literacy is the ability of students to understand material and analyze science and the ability to connect it to everyday life.

Content Knowledge where teachers focus students on mastering science learning materials (Suryanto et al., 2022; Suryosubroto, 1997). Teachers emphasize science materials to students in their learning process in the classroom.

Teachers try to be able to foster students' attitudes and critical thinking through science literacy. Chemistry teachers interpret science literacy as the ability of students to read, understand, evaluate and be able to apply science literacy to make decisions.

In addition, to improve science literacy, learning is carried out with a contextual approach where the learning model invites students to be active and participate, directs inquiry learning and learning products in accordance with improving science literacy.

This is like a statement from one of the participants who stated:

*"Okay science literacy is the ability of students to understand make questions, analyze related to science, and connected to what learning is contextual and I try to present learning that is indeed close to everyday life".*

From the above statement, it can be concluded that the dimensions of teacher literacy focus on the habit of mind. According to Sumartini (2013) Habit of mind plays a role in developing students' creative thinking skills. Students will try to relate learning material to their daily lives.

Furthermore, the teacher said that the dimensions of science literacy also focus on Science as human endeavor. Science as human endevour focuses on how students understand the nature of science, and the relationship between science and society with the realm of science literacy. Where in this case students will be trained to solve and overcome problems or *problem solving*. Chemistry teachers invite students to be able to relate their knowledge of science literacy to their surrounding and daily lives.

Science literacy-based chemistry learning is chemistry learning designed by fulfilling the principles of science literacy, namely identifying problems, explaining scientific phenomena, and using scientific evidence. The teacher is a key factor in the learning process because he plays a role in order to design, implement, and evaluate learning. From the results of interviews, this study shows that to improve science literacy in Chemistry, teachers make several efforts, one of which is the *Students Oriented* method. In this method, Chemistry teachers try to make students active in learning and make them the center of the learning process, while the teacher will only be a facilitator to encourage student activeness. Learning using the *student oriented* model is expected to be able to move students to think critically and then investigate in learning (Ayub et al., 2021; Mansour, 2009; Susiloningsih et al., 2024).

In addition, another effort made by teachers to improve the chemical literacy dimension is by linking existing material with events or phenomena that occur in everyday life.

As one of the participants said:

"*For me, it is more about linking the existing material with events or phenomena that occur in everyday life so that it is more real or contextualized so that it is not nonsense*."

Chemistry teachers also apply *project-based learning* and *problem-based learning* as methods to improve the chemical literacy dimension in differentiated learning. *Project-based learning* is a learning model centered on student activities and at the end of learning a product will be produced. (Dewi, 2021). Meanwhile, *problem-based learning* is a learning model that uses real-world problems as a context for students to learn critical thinking and problem-solving skills, as well as to gain essential knowledge and concepts from the subject matter (Kanah & Mardiani, 2021). (Kanah & Mardiani, 2022).. In addition, Chemistry teachers also apply the discussion method where students will be able to exchange ideas to solve a problem. Discussing helps students to be able to think critically and increase their confidence to argue.

Research on teachers' pedagogical beliefs and their relation to teaching practice has been conducted for approximately 60 years. There is a suspected relationship between the successful achievement of learning objectives and teachers' pedagogical beliefs. Teachers' pedagogical beliefs are a description of the psychological concepts/viewpoints that teachers have regarding how they should teach, manage learning, design and implement learning, evaluate learning outcomes, and actualize the various potentials of students (Pajares, 1992).

There are several categories of teacher belief types including *Teacher Oriented* (Traditional and Instructive Type), Transitional, and *Student Oriented* (Responsive and Reform Based Type). Identification of beliefs can be done by examining teacher documents, interviewing teachers, and checking their consistency with teacher teaching practices in the classroom through observation. Science literacy-based learning demands action and strong confidence from a teacher. Teachers' doubts and insecurities to move students in a complex classroom towards active student learning are obstacles in implementing science literacy-based chemistry learning.

Based on the results of interviews, lesson plan documentation, and observations that have been made, it can be concluded that there are several types of beliefs of Chemistry teachers as participants in this study, namely the responsive type and the reform type. The teachers with the responsive type are teacher A, teacher D, teacher E, and teacher F, while the teachers with the reform type are teacher B, teacher C, and teacher G.

Differentiated learning and science literacy are directed at meeting students' learning needs. This allows students to carry out various activities in accordance with their interests and potential. affect the efficiency of students'

self-development (Palieraki & Koutrouba, 2021; Sundayana, 2016; Suyanti & Sormin, 2016; Wagner & Müller, 2008).

## 4. CONCLUSION

Based on the results of the research that has been conducted, it can be concluded that the pedagogical beliefs of high school chemistry teachers in implementing differentiated learning and science literacy show a positive value even though it is only limited to initiatives and has not fulfilled all science literacy criteria. The lack of emphasis in mastering the nature of science to students and the absence of presenting social issues that cause dilemmas to be solved scientifically by students are the shortcomings of chemistry teachers in general in implementing differentiated learning in the classroom.

In addition, it was also found that the beliefs of high school chemistry teachers in viewing the concepts and strategies of science literacy learning are still in the realm between *teacher oriented* and *student oriented* or in the category of transitional pedagogical beliefs. This shows that the consistency between pedagogical beliefs and teaching practices of teachers cannot be maximized. This study also found that the factors of teachers' educational background, length of time teaching chemistry, and limited facilities are aspects that influence teachers' pedagogical beliefs due to the implementation of learning that sometimes does not match the learning design.

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