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The Influence of the Discovery Learning Model with Socio-Scientific Issues Context on Scientific Literacy Skills and Cognitive Learning Outcomes

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Abstract: Applying the learning model should encourage students to learn actively, think, and use their abilities to discover. Apart from that, learning linked to the SSI context can also support functional scientific literacy skills. StudyThis aims to analyse the influence of the discovery learning model in the context of Socio Scientific Issues (SSI) on students' scientific literacy abilities and cognitive learning outcomes on Basic Laws of Chemistry material. This research uses a quasi-experiment method with a control posttest-only group design—research population of class X students at MAN 10 Jombang. Sampling used the purposive sampling technique, which consists of two classes: the experimental class, which applies the SSI-based discovery learning model, and the control class, which uses discovery learning. Data collection used a 10-item essay test instrument to measure scientific literacy skills and a 15-item multiple choice test to measure cognitive learning outcomes. Both have been validated; the reliability was 0.869 and 0.889, respectively—data analysis using a t-test. The results of the research show that there is an influence of the SSI-based discovery learning model on scientific literacy skills with a 2-tailed sig value of $0.031<0.05$ and student cognitive learning outcomes on basic chemical law material with a 2-tailed sig value of $0.017<0.05$. Based on descriptive analysis of post-test abilities, scientific literacy is known to be the average class score in the experiment is greater than the control class, namely 81,38 > 76,25. In contrast, the average post-test score for the cognitive learning results of the experimental class is greater than that of the control class, namely 85,89 > 80,56.

Keywords: Discovery Learning, Socio Scientific Issues, scientific literacy, cognitive learning outcomes

INTRODUCTION

In the 21st century, the world has experienced relatively rapid development, resulting in students having to have competencies for the world of work, which are not only limited to basic skills but also have to focus on the fact that education can produce professional workers and become capable citizens, intelligent and quality. One of the skills that students must have is scientific literacy because, in the 21st century, scientific literacy has become one of the abilities to survive in facing various challenges and competition (Turiman et al., 2012). However, students in Indonesia demonstrate low levels of scientific literacy, as supported by research conducted by the Programme for International Student Assessment (PISA).

According to research by the Programme for International Student Assessment (PISA), released on December 5, 2023, Indonesia is ranked 68^{th} out of 81 countries with scores in Mathematics (379), Science (398), and Literacy (371). Compared to its ranking in 2018, Indonesia improved from 72nd to 68th. Despite this ranking increase, the 2018 PISA results were higher than those in 2022, where Indonesia scored 396 in scientific literacy. Overall, the PISA results in 2022 are amongst the lowest (Tohir, 2019).

The factors contributing to the low scientific literacy among students stem from various sources, including students, teachers, and schools. Student-related factors include: 1) students' lack of understanding of the basic concepts of science presented by the teacher, combined with a reluctance to ask questions; 2) science education in schools remains traditional mainly; 3) insufficient student ability to interpret tables or graphs; 4) neglect of the significance of reading and writing skills as essential competencies for students; and 5) a lack of student interest in reading and reviewing learning materials (Hidayah et al., 2019).

Considering the factors leading to low scientific literacy outlined above, teachers must possess the capability to communicate effectively and appropriately with their students. Fostering scientific literacy in students necessitates efforts to empower them, one of which involves learning chemistry. Chemistry is a compulsory subject at the SMA/MA level. During the learning process, educators must select a teaching model that aligns with the characteristics of the knowledge being developed, such as discovery learning (Yerimadesi et al., 2017). *Discovery learning* is an approach that positions students at the centre of an active and responsive learning experience.

The discovery learning model requires the learning process to move from a teacher-dominated learning situation to a student-dominated one while the teacher acts as a mediator and facilitator(Udo, 2011). Therefore, an approach is needed that supports the operation of the discovery learning model. The approach used aims to improve scientific literacy skills, which include the ability to understand and hone scientific issues in everyday life. The approach that can be used is socio-scientific, learning, or socioscientific issues(Nurmilawati et al., 2021). Socio Scientific Issues (SSI) was chosen because it has several advantages; namely, it can make chemistry teaching more relevant for students, it can be oriented towards good learning outcomes, it can improve the ability to express opinions, it can improve the ability to evaluate scientific information, and increase chemical literacy (Cahyarini et al., 2016).

The material used in this research is the fundamental laws of chemistry. The basic laws of chemistry can be considered a complex concept in chemistry learning. The basic rules of chemistry are the basic concepts in chemical calculations. Therefore, it is one of the most essential materials in general. Mastery of well-explained material aims to ensure students understand basic concepts so they can be used at the next level (Khairani et al., 2022). Student's comprehension of the fundamental laws of chemistry significantly influences their understanding of subsequent chemistry topics.

METHOD

This research was conducted during the February 2023-2024 academic year at MAN 10 Jombang. This study is a quasi-experimental research with a post-test-only control group design. The research samples consisted of two classes, namely Class XB and Class XC. Class XB comprises 28 students and serves as the control class, employing the discovery learning model. Meanwhile, Class XC, with 27 students, is the experimental class that utilises a discovery learning model within a socio-scientific issues context. The researchers selected Classes XB and XC because these two classes possess homogeneous properties. The homogeneity of the experimental and control classes was tested using the daily test scores from the chapters prior to the introduction of law chemistry, specifically the nomenclature of compounds. The sampling technique applied was purposive. The instruments utilised in this research comprised two types: treatment instruments and measurement instruments. The treatment instruments included LKPD and Teaching Modules. For the data collection technique in this study, instruments assessing students' scientific literacy abilities regarding the fundamental laws of introductory chemistry were employed, consisting of an essay test with 10 questions and a multiple-choice test measuring cognitive learning outcomes with 15 questions. This test was administered at the end of the study (*post-test).* Subsequently, validity and reliability tests were conducted on the instruments.

RESULTS AND DISCUSSION

The research produced two sets of data, namely scientific literacy ability data and cognitive learning outcomes. Data on the scientific literacy abilities of students in the control and experimental classes are summarised in Table 1.

Table 1. Posttest Descriptive Analysis of Scientific Literacy Ability

Class	Lowest Value	The highest score	Number of Values	Mean	Median	Mode
Experiment	62.50	95	2,197.50	81.38	85	85
Control	60	95	2,125	75.89	76.25	85

Table 1 shows the results of the posttest on the scientific literacy abilities of experimental class students. The lowest score was 62.5, and the highest score was 95, for a total of 2,197.5. Thus, an average score of 81.38 was obtained, with a middle score of 85. The mode of the data is 85.Meanwhile, the results of the post-test on scientific literacy skills in the control class indicated that the lowest score was 60 and the highest score was 95, with a total of 2,125 points. This yielded an average score of 75.89, with a median score of 76.25, and the mode of the data was 85. A summary of the post-test descriptive analysis of cognitive learning outcomes for both the experimental and control classes is presented in Table 2.

Table 2. Posttest Descriptive Analysis of Cognitive Learning Results

Class	Lowest Value	The highest score	Number of Values	Mean	Median	Mode
Experiment	66.60	100	2,319.20	85.89	86.60	80
Control	66.60	100	2,255.70	80.56	80	80

Table 2 shows the posttest results on the cognitive learning outcomes of experimental class students. The lowest score was 66.6, and the highest score was 100. With a total of 2,319.2, an average score of 85.89 was obtained, with a median score of 86.6. The mode of the data is 80.Meanwhile, the posttest results on cognitive learning outcomes in the control class showed that the lowest score was 66.6, the highest score was 100, and the total score was 2,225.7. Thus, an average score of 80.56 was obtained, with a median score of 80, and the mode of the data was 80.Tables 1 and 2 show that the average scientific literacy abilities and cognitive learning outcomes of experimental class students are higher than those of students in the control class.

Hypothesis Test Analysis

After calculating the post-test scores from the experimental and control classes, statistical tests were conducted to determine whether the Discovery Learning model, in the context of socio-scientific issues, influences students' scientific literacy and cognitive learning outcomes. These tests included assessments of normality, homogeneity, and hypothesis testing for both classes. The results of the statistical analysis are as follows.

Table 3. Recapitulation of Normality Test Calculations for Scientific Literacy Ability Tests

	Class	Results	Criteria
Normality Test (Shapiro-Wilk)	Experiment	Sig. 0.062 > 0.05.	Normally distributed
	Control	Sig. 0.488 > 0.05	Normally distributed

Table 4. Recapitulation of Normality Test Calculations for Cognitive Learning

	Class	Results	Criteria
Normality Test (Shapiro-Wilk)	Experiment	Sig. 0.098 > 0.05	Normally distributed
	Control	Sig. 0.109 > 0.05	Normally distributed

Based on Table 7, the significance of the first hypothesis test at the 5% significance level is 0.031, or Sig. < 0.05. Consequently, H_0 is accepted, or H_a is rejected, indicating a difference in the average scientific literacy ability between the discovery learning model and the traditional learning model in socio-scientific issues. The results of the second hypothesis test at the 5% significance level show 0.017, suggesting that Sig. < 0.05. Therefore, H_0 is accepted, or H_a is rejected, indicating a difference in the average cognitive learning outcomes between the discovery and traditional learning models in the context of socio-scientific issues.

Table 5. Recapitulation of Homogeneity Test Calculations for Scientific Literacy Ability

	Results	Criteria
Homogeneity Test (Lavene Statistics)	Sig. 0.640 > 0.05	Homogeneous Variance

The results of the third hypothesis test at the 5% significance level reveal 0.00, indicating that Sig. < 0.05. Thus, H_0 is accepted, or H_a is rejected, signifying a relationship between cognitive learning outcomes and scientific literacy abilities within the discovery learning model in the context of socio-scientific issues.

Table 6. Recapitulation of Homogeneity Test Calculations for Cognitive Learning

	Results	Criteria
Homogeneity Test (Lavene Statistics)	Sig. 0.830 > 0.05	Homogeneous Variance

The Influence of the Discovery Learning Learning Model in the Context of Socio-Scientific Issues on Scientific Literacy Ability

The instrument used comprises essay questions designed to assess students' scientific literacy skills. The sample studied included 28 students from class XB as the control group and 27 students from class XC as the experimental group. In class XB, while working on the LKPD, some students tended to be uncooperative. In contrast, the students in class XC showed differences in their responses, being more active, collaborative, and creative. This can be attributed to the fact that, prior to engaging with the

Table 7. Summary of Hypothesis Test Analysis

Hypothesis	**Sig**	**Information**	**Decision**
Hypothesis 1	0.031	0.031 < 0.05	H_0 is rejected
Hypothesis 2	0.017	0.017 < 0.05	H_0 is rejected
Hypothesis 3	0.00	0.00 < 0.05	H_0 is rejected

Scientific literacy abilities can develop through behaviours imparted by teachers, one of which involves learning models. During the learning process, scientific literacy skills serve as a driving force for students, fostering enthusiasm for learning activities. Scientific literacy encompasses the ability to utilise scientific knowledge, frame questions, and draw conclusions based on data and facts in order to comprehend the universe and make informed decisions regarding the impact of human activities on the worl(Toharudin, uus., Hendrawati, Sri Rustaman, 2011). When scientific literacy skills are elevated, they positively influence student learning outcomes, illustrating a reciprocal relationship between scientific literacy abilities and student achievement.

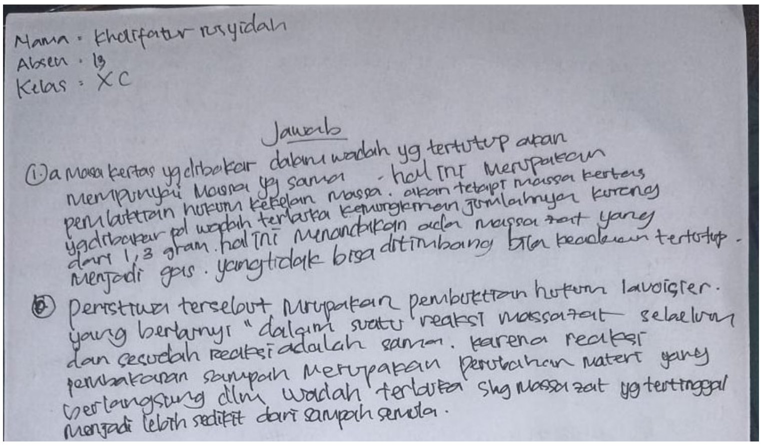
The discovery learning learning model has a socio-scientific issues context. Students can learn actively and discuss with their peers to develop scientific literacy skills, so that teachers can guide and direct students towards correct and appropriate conclusions. Through this learning, students can develop scientific literacy skills in increasing their understanding of the basic legal material of chemistry. This is in accordance with research conducted by Nur Aida Afrilia, Neti Afrianis and Nurhadi in 2022. Research results This proves that there is a significant influence on scientific literacy skills. The *n-gain* score obtained shows Students' scientific literacy abilities have increased significantly with the 'high' category for class XI MIPA 2 and the 'medium' category for class XI MIPA 3. Results of initial and final data analysis obtained $t_{hitung} = -22.491$, $-t_{tabel} = -2.0301$ and $+t_{tabel} = 2.0301$ at the 5% significance level. Mark $-t_{hitung} < -t_{tabel}$ and $t_{hitung} > t_{tabel}$ so that H_0 is rejected, and H_a is accepted means showing the influence of applying the Socio Scientific approach Issues (SSI) on students' scientific literacy abilities on oil material class XI MIPA at SMA Negeri 5 Pekanbaru (Nurhadi, 2022).

Apart from that, there is also research conducted by Putri Maya Sari, who explained students' low scientific literacy abilities and students' scientific attitudes, which are known through pre-research scores. This is because the learning process in class is still theoretical and centred on educators, so there is more one-way communication (One-way Communication). The results of this research were obtained in class. The experiment obtained an average score of 70, while the control class received an average of 55 for scientific literacy skills. This means that the posttest average of the experimental class is greater than that of the control class's scientific literacy and argumentation skills, so it can be said that the Socio Scientific Issues (SSI) strategy influences students' scientific literacy abilities (Sari, 2021).

The Influence of the Discovery Learning Model in the Context of Socio-Scientific Issues on Cognitive Learning Outcomes

Based on the results of data analysis regarding the cognitive learning outcomes of the experimental and control classes, using the independent t-test, it is evident that the significance value is 0.017, which is less than 0.05. The data analysis indicates that H_a is accepted while H_0 is rejected. Therefore, the discovery learning model, contextualised by socio-scientific issues, significantly influences the cognitive learning outcomes in class X basic chemistry law material at MAN 10 Jombang. Furthermore, the average results for the experimental class were superior to those of the control class, at 85.8 compared to 80.2. The cognitive learning outcomes assessed in the study were confined to cognitive levels C1-C4 via multiple-choice post-test questions. The C1 cognitive learning outcomes for students correspond to questions number 6 and number 11, which address the fundamental laws of chemistry as stated by Proust and the application of Gay-Lussac's law. The learning outcomes at cognitive level C3 are found in post-test question number 1, encompassing the concept of reaction rate and collision theory. C3 cognitive level questions comprise ten items: numbers 1, 3, 4, 5, 7, 8, 10, 12, 13, and 15. These questions involve calculations of mass based on Lavoisier's law, determination of mass ratios according to Proust's law, assessment of mass ratios based on Dalton's law, computation of gas volume as per Gay-Lussac's law, and calculations of the number of molecules according to Avogadro's law. At the C4 cognitive level, three questions are present at numbers 2, 9, and 14, which cover reaction equations based on Lavoisier's law, comparison of element masses according to Dalton's law, and analysis of the applications of Avogadro's law in everyday life.

The issues raised encompass all the fundamental laws of chemistry, namely Lavoisier's Law, Proust's Law, Dalton's Law, Gay-Lussac's Law, and Avogadro's Law. In relation to Lavoisier's Law, social issues arise concerning the provinces that generate the most waste in Indonesia. One potential solution to the problem of accumulating waste is to process or incinerate it; however, what frequently occurs in society is incineration. This combustion process can be associated with Lavoisier's Law. Furthermore, in Proust's Law, the social issue highlighted is the death of a person due to a drug overdose. In this instance, students are prompted to consider the ingredients in the medication and then compare the percentages of the compounds or elements, which can be linked to the law of constant proportions. Regarding Dalton's Law, the issue brought up pertains to the presence of hazardous gases (CO and CO_2) that contribute to the rising temperatures of the earth. Students are then tasked with identifying whether there are two elements that can form more than one compound, where the mass of one of the constituent elements is constant; thus, the ratio of the masses of the other elements in the compound is a simple whole number, aligning with the law of multiple ratios (Dalton's Law). In the case of Gay-Lussac's Law, the issue highlighted involves new innovations related to green ammonia technology. After students successfully identify the reaction equation for the industrial formation of ammonia gas, namely through the Haber-Bosch process, they can then analyse the volume ratio based on the coefficients, which is consistent with Gay-Lussac's Law. Finally, with regard to Avogadro's Law, the issue raised is the production of biogas to alleviate fuel shortages. In this case, students are able to write the reaction equation for the combustion of methane gas and subsequently identify the number of molecules.



Nama : Khalifatur rasyidah
Absen : 13
Kelas : X C

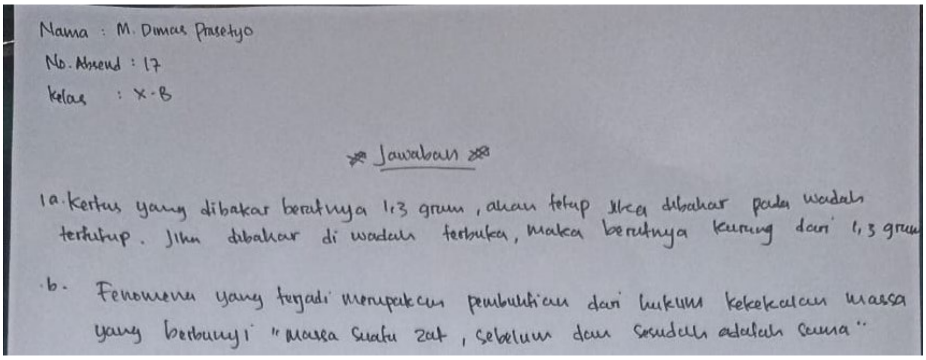
Jawab

1. a Massa kertas yg dibakar dalam wadah yg tertutup akan mempunyai massa yg sama . hal ini merupakan pembuktian hukum kekekalan massa. akan tetapi massa kertas yg dibakar pd wadah terbuka kemungkinan jumlahnya kurang dari 1,3 gram. hal ini menandakan ada massa zat yang menjadi gas. yang tidak bisa ditimbang bila keadaan tertutup.

b. Peristiwa tersebut merupakan pembuktian hukum lavoisier. yang berbunyi "dalam suatu reaksi massa zat sebelum dan sesudah reaksi adalah sama. karena reaksi pembakaran sampah merupakan perubahan materi yang berlangsung dlm wadah terbuka shg massa zat yg tertinggal menjadi lebih sedikit dari sampah semula.

Figure 1. Experimental Class Answer

Learning outcomes are the results students achieve after gaining experience from the learning process in a subject at school. The significance of learning outcomes in chemistry is that students can comprehend concepts, explain the relationships between them, and apply this knowledge in everyday life. Students who engage with the discovery learning model within a socio-scientific issues context are encouraged to participate actively in the learning process. They independently discover the concepts they have learned based on the problems presented in the LKPD, ensuring they gain meaningful experiences that are more deeply embedded in their minds. This provides examples of student responses between the experimental class and the control class:



Nama : M. Dimas Prasetyo
No. Absend : 17
Kelas : X-B

Jawaban

1a. Kertas yang dibakar beratnya 1,3 gram, akan tetap jika dibakar pada wadah tertutup. Jika dibakar di wadah terbuka, maka beratnya kurang dari 1,3 gram

b. Fenomena yang terjadi merupakan pembuktian dari hukum kekekalan massa yang berbunyi "Massa suatu zat, sebelum dan sesudah adalah sama"

Figure 2. Control Class Answer

The picture above indicates that the answers from the students in the experimental class were more varied and could be explained in detail. This aligns with research conducted by Khusnul Mudawamah, which demonstrates that socio-scientific approach issues influence the learning outcomes of Year VII students in a polluted material environment. The research findings reveal a significant increase in student learning outcomes in Cycle 1, averaging 71.51, and in Cycle 2, averaging 80.93. The outcomes of the students' science process skills show an average of 75.39 in Cycle 1 and 93.15 in Cycle 2 (Mudawamah, 2020).

The Influence of the Discovery Learning Learning Model Context of Socio-Scientific Issues on Scientific Literacy Abilities and Cognitive Learning Outcomes

In the learning process, employing the discovery learning model within the context of socio-scientific issues, students organise, create, and present the outcomes of discussions assigned by educators, ensuring that they fully engage in the learning process. This approach renders the learning experience more meaningful for students, enhancing their level of understanding and fostering creativity in their organisational skills. During the syntax or verification step, each group will present their discussion outcomes to the class, which will bolster students' self-confidence and communication abilities. As groups present their project results, other students will listen, ask questions, and offer opinions regarding the material discussed, further enriching their understanding and improving scientific literacy skills through the question-and-answer interactions about the socio-scientific issues addressed in the completed LKPD.

The LKPD based on discovery learning within the context of socio-scientific issues used in experimental classes encourages students to consider the social issues presented. During the stimulation and data collection stages, the LKPD employs a scientific approach featuring social issues that frequently arise daily. The topics presented include news articles and videos, which are subsequently linked to fundamental chemistry content. Ultimately, students grasp the material and establish connections between it and everyday phenomena. This will undoubtedly enhance their scientific literacy, as it pertains to the skills necessary to connect science with relevant issues and concepts, cultivating a reflective society. Students are encouraged to express their opinions based on their understanding and the data obtained, with the teacher guiding them towards accurate conclusions. Consequently, students are more eager to continue learning, resulting in positive outcomes. This approach contrasts with students who engage with the discovery learning model without any supplementary context. While the cognitive learning outcomes between the experimental and control classes show minimal differences due to both utilising the discovery learning model, notable disparities exist in their scientific literacy abilities. In the latter model, social issues, readings, and videos illustrating the practical application or relationship of the material to everyday life are absent. For assignments, the LKPD is presented in books typically used in the library for learning purposes. This approach lacks variety, as students can only study the material without relating it to phenomena frequently occurring in their lives. Thus, scientific literacy skills tend to be further enhanced in experimental classes by incorporating a socio-scientific issues approach.

Utilising a diverse or varied learning model can aid in achieving the desired learning objectives. The attainment of a learning objective can be observed following the assessment process conducted on students. The aims of this learning may include changes in behaviour as well as the enhancement of skills and knowledge. One learning model that educators can implement is the discovery learning model within a context of socio-scientific issues. This is due to the fact that the syntax or steps involved in learning through the discovery learning model in the context of socio-scientific issues can impact student behaviour, particularly regarding changes in cognitive learning outcomes and variations in students' levels of scientific literacy. The syntax of discovery learning in the context of socio-scientific issues is highlighted in the stimulation stage, where examples or social issues are presented via articles, news, or videos. Subsequently, during the data collection and processing stage, students engage with LKPD, which encompasses a socio-scientific context, followed by the verification stage in which the teacher invites students to present their LKPD work.

CONCLUSIONS

Based on the research results, it was concluded that: 1) the use of learning models *such as discovery* learning, contextual learning, and socio-scientific issues influences scientific literacy abilities; 2) the use of these learning models *also affects* cognitive learning outcomes; 3) there is an impact from the use of these models *on both* scientific literacy abilities and cognitive learning outcomes. There are several suggestions, including: 1) For schools, always strive to provide adequate facilities. This includes improving skills, facilities, and infrastructure to enable effective and efficient learning. The head of the madrasah can encourage the teaching staff to develop their teaching abilities by employing appropriate learning models that meet students' needs. 2) Educators should actively engage in becoming more creative and innovative when selecting the right learning strategy, where the strategy chosen aligns with the material to be taught, consistently fostering a pleasant teaching and learning atmosphere essential for developing the skills necessary for this century, such as scientific literacy, critical thinking skills, and more. 3) Future researchers are encouraged to develop Discovery Learning models using suitable approaches and diverse materials that keep pace with contemporary developments. This aims to help students understand the material better, and this research can serve as a reference for future studies.

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