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The Effect of Environment Analogy-Based Discovery Learning to Improve Students' Environment Literacy and Understanding on Thermochemistry

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Abstract: The Effect of Environment Analogy-Based Discovery Learning to Improve Students' Environment Literacy and Understanding on Thermochemistry. This research is the result of the implementation of thermochemistry learning based on the reconstruction of the analogy environment-based discovery learning model (DLBAE). The purpose of this study was to determine the effectiveness of the DLBAE learning model in thermochemical context chemistry lessons at SMAN 4 Jayapura students. The research method is the result of experimental treatment analysis which is divided into two groups (conventional control model and experiment with DLBAE model). The results of the implementation showed that the analysis test of sig (2.tailed) < 0.05, indicated that there was a significant difference between the conventional model and the DLBAE model. Based on the acquisition of the average chemical value of the experimental class 77.05 > from the control class 64.64. Meanwhile, the percentage of environmental literacy ability is between 80-90%. Student response to DLBAE-based thermochemistry learning was very positive. Based on the results of the analysis, the DLBAE-based learning model is very effective to use, in order to increase understanding of concepts and environmental literacy.

Keywords: discovery learning, analogy, environment literacy.

Abstrak: Pengaruh Pembelajaran Discovery Berbasis Analogi Lingkungan untuk Meningkatkan Literasi Lingkungan dan Pemahaman Termokimia Siswa. *Penelitian ini merupakan hasil implementasi pembelajaran termokimia berdasarkan rekonstruksi model discovery learning berbasis analogy Environtment (DLBAE). Tujuan penelitian ini adalah untuk mengetahui efektifitas model pembelajaran DLBAE pada pelajaran kimia konteks termokimia pada siswa SMAN 4 Jayapura. Metode penelitian merupakan hasil analisis perlakuan secara eksperimen yang dibagi dalam dua kelompok (Kelas Kontrol dengan model konvensional, serta eksperimen dengan model DLBAE). Hasil implementasi menunjukkan uji analisis sig (2-tailed) < 0,05, menunjukkan terjadi perbedaan yang signifikan antara model konvesional dan model DLBAE. Berdasarkan perolehan nilai rata-rata kimia kelas eksperimen 77,05 > dari kelas kontrol 64,64. Sedangkan persentasi kemampuan literasi lingkungan berada diantara 80-90%. Tanggapan siswa terhadap pembelajaran termokimia berbasis DLBAE adalah sangat positif. Berdasarkan hasil analisis, maka model pembelajaran berbasis DLBAE sangat efektif digunakan, guna peningkatan pemahaman konsep dan literasi lingkungan.*

Kata kunci: *pembelajaran discovery, analogi, literasi lingkungan.*

▪ INTRODUCTION

Learning chemistry with a discovery learning (DL) approach is important for students, for concepts that are difficult to reach. In some chemicals, there are things that are difficult to reach, so we need the right approach to get information more easily. Based on this approach, it is hoped that there will be an increase in students' retention of old memory. (Clabaugh, 2009; Mandrin & Preckel, 2009). Excellence in the discovery learning model learning process shows that students can interact with the learning environment socially, which is because they practice problem solving, practice and work with new ideas in groups (Champine, et al 2009). As is known, that the basic concept of discovery learning is that the teacher must facilitate instruction that allows students to find predetermined results in learning based on asking questions given to students. Discovery learning has widely played an important role in learning and has a direct impact on students' cognitive development (Anderson & Krathwohl, 2001).

Based on several observations of chemistry learning, the context of thermochemistry is one of the materials that is difficult to understand by many students, especially in the context of energy exchange between the system and the environment based on the laws of thermodynamics. The combination of discovery learning with the environment including the practicum process in the classroom and in an open environment has made it easier for students to interpretation the concepts of science material given. Based on the constructivist perspective, that "education is a process of personal discovery" (Madrin & Preckel, 2009). Inventions based on science material have been able to increase students' knowledge, how students direct their thinking skills to be able to find directions given by the teacher.

Through the design of learning materials, students are expected to be able to find a search, process until the actual theoretical concept is found. Chemistry learning approaches refer to the inclusion of the environment that many educators do, in order to improve the quality of students so as to provide a significant improvement in science learning. As with the discovery learning approach, namely inquiry-based and constructive learning (Champine et al., 2009), where the discoveries are directed at the existing environmental conditions. In addition, several chemical approaches have been taken to make it easier for students to understand chemical concepts, for example based on virtual labs (Ambusaidi et al., 2017), green chemistry, computer simulations by designing the environment as a visual image (Ahmad et al., 2021; Doloksaribu & Triwiyono, 2021; Sharif et al., 2021; Saudale et al., 2019; Rhedana & Maharani, 2017). In this case, the environment-based chemistry learning approach plays a major role in the progress of the teaching and learning process.

Through the learning approaches mentioned above, there are several things that educators need to attention, namely what are the actual results of observations of learning models in certain areas which are sometimes generalized to the ability of schools in areas with advanced and available learning facilities. The curriculum throughout the country is indeed the same, but the facilities and conditions in each region vary widely, ranging from very sophisticated to an alarming level. If given a number, the condition of the facilities and the level of student ability can be from level 10 to 1. In this condition creative chemistry teachers are needed, in order to improve students' understanding of concepts in conditions of lack of learning facilities. In this case, the environment and its analogies can be used as navigation for chemistry learning so that material concepts enter students' thinking (Doloksaribu et al., 2020; Marpa, 2020). Thus, it is hoped that the attitude towards environment-based learning can increase student learning activity (Aryani & Suastra, 2013; Ozalemdar, 2021).

Based on the learning approaches that have been described above, the tendency is that the environment is a good thing to be applied to students in order to increase understanding of concepts. Meanwhile, several learning models that are often used related to the environment are discovery learning (Champina, et al. 2009). Discovery learning learning model, is a learning model that can build the character of students (Feriyanti, 2014), increase the role of students in learning, as well as improve students' critical thinking skills. Even some schools provide discovery learning models as the basis for learning models in schools in order to improve the quality of science in the 21st century era, (Rudibyani, 2018; Inde, et al, 202; Putra, et al, 2020).

Based on the results of observations, by reconstructing environment based learning modules and models and analogies of everyday life, it can help students understand the basic concepts of chemistry more easily. This condition will greatly help students and schools who experience learning difficulties due to the lack of chemistry learning facilities (Doloksaribu, et al, 2020).

The same approach for all students, has given different results, benefiting students who are quick to understand, but detrimental to students who are less able. (Doloksaribu & Triwiyono, 2021). It is better to stick to the principle of an approach based on student needs, without ignoring the principles of education that are set nationally (Duit, 2007; Komorek, & Kattmann, 2009; Duit, et al, 2010; Duit, et al. 2012). The pattern of reconstruction in the learning model is based on problem criteria that are already known to educators, making it easier for students to understand the material. It is undeniable that there has been an education gap in Indonesia for a long time, which results in different job competitions in each region, especially schools that are far from urban areas (Vito, et al, 2015). But whatever the challenges faced by education, the teacher is one of the sources of change to improve the quality of students. Therefore, the success of educational change depends on the quality of the teaching staff (Josephus Primus, 2015).

Some students have difficulty understanding the concept of chemistry, due to the teacher's lack of observation of individual students. Most teachers see student learning outcomes based on chemical values in a material context, and not based on process by process sub-concepts of the material that students get. In this case, some science process skills are expected (Suryawati, 2020; Champine et al. 2009).

Through the phenomena above, try to combine discovery learning learning models with an analogous environment, so that the basic concepts of chemistry can be understood by students based on environment analogies or daily activities that have been known. The reconstruction of the discovery learning model based on the analogy environment (DLBAE) has been reconstructed and limited testing and model validation have been carried out to determine the feasibility of the model being widely implemented.

▪ METHOD

Participants in this study consisted of two groups that had been divided according to the available groups, and was conducted at SMAN 4 Jayapura. The participants consisted of 60 students, who were divided into two control groups and an experiment group. In the control group, lecture material was given using a conventional model, namely learning materials that were already available at school. While the experimental class uses a reconstructed module, namely thermochemistry based on analogy-based discovery learning and the environment.

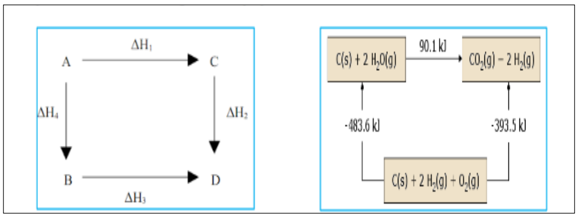
The research design is the result of developing by model education reconstruction an analogy-based discovery learning model (DLBAE). The instruction model developed in accordance with the DLBAE indicators is a combination of everyday environment analogies. The learning model developed is in accordance with the curriculum on thermochemical context material. The learning process starts based on the learning syntax. In the environmental analogy-based material model approach, the emphasis is on responding to the objectives of the research. As said, all materials concerning thermochemistry are combined with analogous texts to the environment and everyday life, ranging from energy, energy exchange, the relationship between energy and work, and other laws of thermodynamics. Some texts have been analogous to the environment or everyday life, for example as in Table 1.

Table 1. Text of Matter and Analogy of Thermochemistry Text

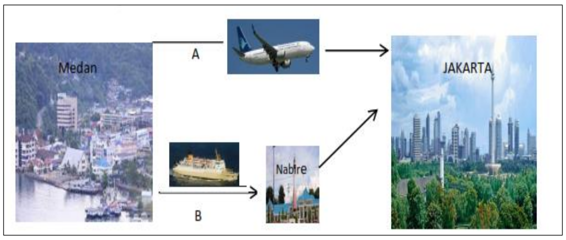
No	Material Content	Analogy Content
1.	Enthalpy is a rule in thermodynamics that states the amount of internal energy, volume and heat pressure of a substance. Enthalpy cannot be measured directly, only the change can be assessed. The enthalpy change is the change in energy from the beginning to the end of a chemical reaction. This law is closely related to the law of conservation of energy.	We can analogize the enthalpy of a substance as money stored in a bank, the customer only knows the amount of money (energy) he receives or leaves the bank, for example money in the form of a loan (energy is received), or the customer knows the amount of money he puts into the bank. (energy released)
2.	Work is not a state function, meaning that the amount of work is not only calculated from the initial state and final state, but the course of the process affects the amount of work done. The heat (q) that occurs in a process depends on how the process takes place	For example, a weight lifting Athletics, with a badminton Athletics, has a different exercise process so that the required heat is also different.
3.	The enthalpy change that accompanies a reaction is influenced by the amount of substance, the physical state of the substance, temperature, and pressure. Almost all processes that occur in chemical reaction systems are carried out at constant external	The change in enthalpy can be analogized as when our bodies weaken we can feel that we are sick, and as time goes by we can feel that we are healed, but we do not know the healing process that is taking place in our bodies.

	volume and pressure. If a chemical reaction takes place at a constant volume, it means that no work is taking place.	
4.	Endothermic reaction is a reaction that is accompanied by the transfer of heat from the surroundings to the system. An exothermic reaction is a reaction accompanied by the release of heat from the system to the surroundings. The reverse reaction is called an exothermic reaction.	Endotherms are analogous to customers who want to save money in a bank. The bank is like a system that accepts money from customers (the environment). Our money is like energy, because the bank (system) receives money (energy) from customers (environment) then money will increase in the bank. Likewise the opposite analogy for exothermic reactions.
5.	Hess's law, namely "the change in enthalpy of a reaction only depends on the initial state (the reactants) and the final state (the products of the reaction) of a reaction and does not depend on how the reaction proceeds". The H of the reaction can be calculated using Hess's law.	Hess's law can also be analogous to someone who wants to go to Jakarta. Person A departed from Jayapura to Jakarta by plane. Meanwhile, person B departs using sea transportation with a time of 4 days 5 nights with several transits at ports such as the port of Nabire

Some of the analogies used are the exchange of energy between the system and the surroundings. An example of a reaction based on Hess's law can be analogous to someone leaving for a destination, but going through several transits, and finally getting to the specified destination. The figure below is the reaction of Hess's law and its analogy in everyday life (Figure 1a).



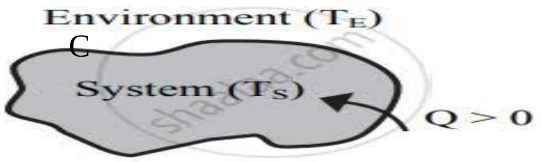
(a)



(b)

Figure 1. (a) Hess Law Process Schematic Diagram, (b) Hess Law Analogy

Figure 1a is a step-by-step process for the enthalpy reaction and the analogy is like Figure 1b, which is like a person going to a city with several transits. Figures 2a and 2b illustrate the process of energy transfer between the system and the environment.



\

(a)

(b)

Figure 2 (a). Transfer of calor of system and environment, (b) Energy Transfer Analogy

In Figure 2a, is the process of energy transfer between the system and the environment, which involves exothermic and endothermic reactions. This situation can be analogous to a money transfer in a bank, as shown in the pigure 2b. Two components of the text consisting of the basic text of thermochemistry and analogy text became the basis for the material presented to the experimental group students, while the basic thermochemistry text was only given to the control group students. In accordance with the existence of each module. With the materials provided to students, students can ask what questions can be presented so that they can draw conclusions based on the findings they find `12 qin the descriptions of the text and images presented to answer the various questions given. The results of the students' scores in the control class and the experimental class were presented based on the pretest and posttest. Next, compare the two acquisitions based on the quality or improvement of students' conceptual abilities. To determine the effectiveness of the implementation of the learning model, statistical test analysis was used (Kariadinata, & Abdurahman, 2012; Sundayana, 2014).

In addition, an analysis of the question and answer instrument was also carried out to determine student responses to the given DLBEA learning model. The assessment given to students was a question that had been described based on discoveri learning indicators based on environmental analogy, it aims to determine the extent to which students understand the concepts thermodynamic chemistry concepts. The ability of the cognitive domain, based on operational work from C4 to C6, becomes the focus of giving questions. This situation is also to determine the level of higher-order thinking skills of students which is the benchmark for national education. In addition, several affective domains were assessed, in order to determine the improvement of students' attitudes towards their daily environment literacy skills, thus supporting the ability to understand thermochemical concepts. Psychomotor skills of students can be known based on how students carry out activities reporting tasks given by the teacher

The pretest posttest questions given are in the form of multiple choice as many as 20 items. Questions 11,12,15,17,18,19, and 20 are designed based on environmental analogies in the cognitive domains C4 to C6, to determine students' higher-order thinking skills based on discovery learning indicators. Meanwhile, the affective ability and environmental literacy are based on the students' ability to solve the questions correctly according to the questions posed in the description of the questions based on the environment. So that the ability to analyze questions becomes a reference for students in understanding their environment literacy skills. The series of cognitive domains can be seen in Table 2.

Table 2. Cognitive Domain Thermochemistry Context

Cognitive Domain	Concept	Test Number	Percentage (%)	Score
C1-C2 C3-C4 C5-C6	1. Energy and its Changes 2. Enthalpy and ita Change 3. Determination of enthalpy change 4. Bond Energy 5. Aplication	1,2,3,4,5,6 7,8,9,10,13,14,16,19 11,12,14,15,17,18,,20	30 40 40	Final Score $= \frac{Value\ Obtained}{20} x100$
Total		20	100	100

Specifically, the questions in the experiment group focused on implementing environment analogies in order to determine students' environment literacy skills. The concept of environment literacy is found in the C4, C5 and C6 domains. The ability to complete the components of the questions is an indicator that students have environment literacy skills.

Table 3. The Division of Control and Experiment Class Groups

School	Group	Observation1)	Learning Time	Learning Model	Observation (2)
SMAN4	1. Control Class	Pree Test	4 week	KV	Post Test
	2. Experiment Class	Pree Test	4 week	DLBEA	Post Test

▪ RESULT AND DISCUSSION

The learning model used by the control class is the learning model and teaching materials that were previously used as well as the teaching materials used. Meanwhile, the experimental class used is based on reconstruction and the teaching module used is a thermochemistry module based on DLBEA. The result of obtaining the average post test score for the control class was 64.64 and the experimental class was 77.05 with a 95% confidence level, as shown in Table 4.

Table 4. Average of Post Test for Control and Experiment class

Test	Group	N	Mean	SD
post-test	Control	30	64,6462	17,02540
	Experiment	30	77,0588	5,23937

Based on the results of the control normalization test Asymp.sig. (2-tailed, 0.459) where sig> 0.05 and the experimental Asymp.sig.(2-tailed, 0.054) where sig>0.05 (Normal data). The homogeneity test of the data is sig 0.067, sig > 0.05 (homogeneous data) Based on the normal and homogeneous test, a t-test of the N-gain value was performed. The results of the analysis can be seen in Table 5.

Table 5. Results of Statistical Analysis of N-Gain Value

Normal distribution Test		**Test of Homogeneity of Variances**		**t-test for Equality**	
N_A, N_B (30 + 30)	60	Sig.	.067	Sig. (2-tailed)	.000
C. Asymp. Sig. (2-tailed)	.459	Sig > 0,05	Ha	Sig. (2-tailed)<0.05	
E. Asymp. Sig. (2-tailed)	.054				

Based on the t test (Table 5), where Sig.(2-tailed) <0.05 indicates there is a significant difference between the control class and the experiment class, it is very possible that there is a change in the treatment given to the experiment class through the development of a discovery learning model based on environmental analogy. reconstructed according to the level of student needs through field observations. As the opinion (Duit, 2010), that the learning approach is in accordance with the observed needs of students, can reconstruct the model as needed by students and the desired goals, and can greatly improve the quality of learning and student abilities. Based on the analysis of environment literacy (Figures 1 and 2), showing the percentage of students' abilities in environment literacy is shown in Figure 3.

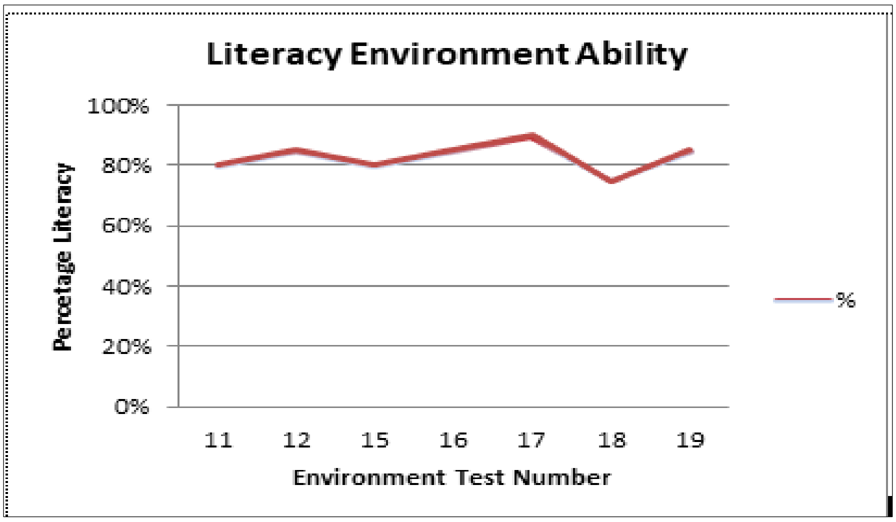


Figure 3. Percentage of Environment Literacy

The results of the analysis of questions number ,15,17, 18, 19, and 20 in the control class, show students' skills in environment literacy. As has been explained, the questions are designed according to environment literacy indicators. The students' environment literacy skills are in the range of 75% to 90%, in all test numbers. The average environment literacy ability of students is 82.8%. This shows that based on the DLBAE model, it has made a very good contribution to students' understanding of thermochemical material. DLBAE-based thermochemistry learning is one of the alternative approaches that can be given to students.

In addition, the instrument was distributed to students, to find out how students responded to the DLBAE-based thermochemistry learning process. The context of the statement is directed at (a) how much need for DLBAE-based thermochemistry learning to be used, (b) whether students' abilities increase after participating in the learning process, (c) the ability to analyze environment analogies, (d) whether the learning model increasingly stimulates student learning, (e)) learning model can increase the value of chemistry than before. Based on the results of the student attitude scale analysis on the criteria of VNT (very not true), NT (Not True), T (True), and VT (Very True) shown in Figure 4.

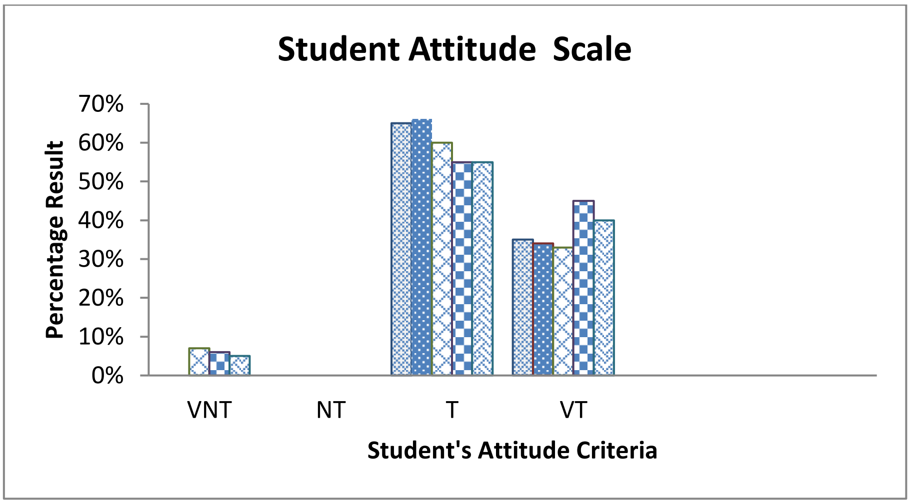


Figure 4. The Scale of Students' Attitudes towards Learning

The average response of students in the learning process is in the true and very correct classification, or the tendency is positive and very positive responses. Most of the responses are on the need for this learning model to be carried out in thermochemical context chemistry learning, because it can greatly improve the ability of students after this learning model is carried out.

▪ CONCLUSION

There is no significant difference in student learning outcomes with the MM type of cooperative learning model compared to the TSTS type of cooperative learning model. The increase in student learning outcomes with the MM type of cooperative learning model was 68% while the increase in student learning outcomes with the TSTS type of cooperative learning model was 69.9%.

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