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# Accelerating Young People's Disaster Literacy With Problem-Based Learning-Root Cause Analysis

**Ramdan Afrian[1,2*], Sugeng Utaya[1], I Komang Astina[1], Syamsul Bachri[1]**
[1]Department of Geography, Faculty of Social Sciences, State University of Malang, East Java, Indonesia
[2]Department of Geography Education, Faculty of Teacher Training and Education, Samudra University, Aceh, Indonesia

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Corresponding Author
E-mail:
ramdan.afrian_geo@unsam.ac.id

**ABSTRACT**
This study aimed to determine how effective the PBL-RCA learning model is in improving student disaster literacy. The method used was quasi-experimental, with a pretest posttest nonequivalent control group design. The class was divided into an experimental class with PBL-RCA and a control class with learning as usual. This study used an instrument adapted from Zhang and Cheng in the form of 50 question items representing indicators of disaster literacy. The experiments indicate that PBL-RCA can increase student disaster literacy. This approach spurs students to read, explore, and improve experiences that can increase their disaster literacy.

## INTRODUCTION

Indonesia is a disaster-prone region. In 2020–2021, 10,052 incidents were recorded, which caused 1,104 people to die and 14,427,399 people to experience losses (National Disaster Management Agency (BNPB), 2020, 2022). Indonesia's location means it will continue to have a high risk of disasters. Disaster literacy is essential to reduce the risk of catastrophe (Chandra, 2021).

Disaster literacy makes people more aware of the potential for disasters. Adi Maulana stated that poor disaster literacy means people do not know about disaster mitigation and how to prevent and prepare for disasters (Vinta, 2023). Anurogo stated that disaster literacy aims to increase public awareness and strengthen the capacity of individuals and institutions to deal with disasters (Anurogo, 2023).

Indonesia's literacy level is low (Suparya et al., 2022). Evidence of this can be seen in the 2019 Program for International Student Assessment (PISA) rankings from the Organization for Economic Co-operation and Development (OECD). Indonesia was ranked 62nd out of 70 countries or among the ten countries with the lowest literacy rate globally (Ilham, 2022). This observation is reinforced by a study of four countries studied in Japan in 2009: Japan, Sri Lanka, the United States, and Indonesia. The results reveal that Indonesia has a very poor literacy rate (Chandra, 2021).

One solution to overcome the problem of low literacy is education. Natural disaster preparedness education, including a learning model, is needed to improve school disaster education (Saregar et al., 2022). The Ministry of Education and Culture also supports disaster education, actively issuing the Disaster Safe Education Unit program (Effendy, 2019). The Aceh government also formulated a draft of the Aceh Disaster Education Qanun, which consists of 14 chapters and 40 articles (Academic Manuscript Preparation Team, Syiah Kuala University, 2019). The tangible form of such solutions and regulations is the learning model.

The problem-based learning (PBL) model is one approach to overcome these problems. Problem-based models can encourage students to think critically and objectively and analyze issues in the field (Bashith & Amin, 2017; Sumarmi, 2012; Ware & Rohaeti, 2018). PBL focuses on authentic

problem-solving so that students can develop higher skills and organize their knowledge, which can improve literacy (Hosnan, 2014).

PBL is expected to improve abilities when combined with root cause analysis (RCA). RCA can provide various alternative solutions to overcome problems that occur. The American Society for Quality defines the following: "Root cause analysis is an essential component of sustainable growth and a more comprehensive approach to problem-solving. Therefore, one of the fundamental pillars of an organization's continuous improvement efforts is the root cause analysis. Root cause analysis should be part of a larger effort to solve problems to achieve quality improvement goals, as they will not result in improvements." (Cerniglia-Lowensen, 2015; Ma, Li, & Thorstenson, 2021). RCA involves planning and exploring the problem to find the cause while also investigating side effects (Pham et al., 2010).

There has been little research on the application of PBL combined with RCA in education, especially regarding disaster literacy. This is evidenced by the limited number of journals that can be used as a reference regarding the influence of RCA in learning, especially problem-based learning with root cause analysis (PBL-RCA). Suharini et al. conducted PBL research on literacy, titled "Disaster Mitigation Literacy Strategies through Problem-Based Learning (PBL) in Schools Prone to Flooding," which aims to explain the influence of disaster mitigation literacy strategies through PBL learning in schools prone to flooding. However, this study did not involve RCA (Suharini et al., 2020). Meanwhile, Serdar Kum and Bekir Sahin conducted RCA research titled "A Root Cause Analysis for Arctic Marine Cancellation from 1993 to 2011." This paper focuses on marine accidents in the northern region from 1993 to 2011 to determine the causes (Kum & Sahin, 2015).

The novelty of this study also lies in strengthening PBL with RCA steps. This combination has not been reported in articles in the last five years, according to bibliometric searches using the VOSviewer application. Search results revealed that there has been no research on PBL related to RCA. Further, if a search uses the keywords "problem-based learning" and "disaster literacy," several disaster literacy studies are found, but they have no connection with RCA.

## RESEARCH METHODS

### Research design

This study used a quantitative approach and quasi-experimental research. The pseudo-experiment used a pretest-posttest control group design, in which the pre-and post-test results of the experimental and control groups were compared to determine the effectiveness of the experimental treatment. The implementation involved two classes: an experimental class that used PBL learning combined with RCA and a control class that used a lecture learning method. The experimental class performed PBL-RCA steps using the syntax shown in Figure 1. Students were required to provide and apply alternative solutions to problems.

This study used an instrument adapted from Zhang and Cheng, which consisted of 50 question items assessing disaster literacy. Lecturers acted as facilitators and provided direction and observation to students regarding the effectiveness of PBL-RCA learning.

Table 1. Research Design

| Class | Preliminary Test | Treatment | Final exams |
|---|---|---|---|
| Experimental | O1 | X | O2 |
| Control | O3 | - | O4 |

(Source: Research Data, 2024)

Information:
O1 : Pretest for Experimental Classes
O2 : Posttest for Experimental Classes
X : PBLRCA Learning
O3 : Control Class Pretest
O4 : Posttest for Control Class
- : Lecture Method

Before collecting research data, disaster literacy measurement instruments must be valid and reliable; therefore, validity and reliability tests must be carried out first. The implementation of PBL-RCA learning was integrated into a student activity guide sheet, which was compiled based on learning syntax. The experimental and control classes completed pretests through assessment instruments at the beginning of learning. After the PBL-RCA learning treatment was applied to the experimental class, a disaster literacy posttest was carried out for the experimental and control classes using the same questions in randomized order. The pre-and post-test scores were then analyzed for normality and homogeneity to ensure the data were suitable for hypothesis testing. If there was a significant difference between the experimental and control class data, then the PBL-RCA learning model was considered to affect disaster literacy.

**Participants**

The participants in this research were students of the Geography Education Study Program, Faculty of Teacher Training and Education, University of Samudra, who were studying the Disaster Geography course for the 2020–2021 academic year. Students were chosen because learning on campus has a relatively long duration, so PBL's issues regarding time demands could be overcome. The control class consisted of 29 students and the experimental class of 31 students. The ability of students in both classes was approximately equal, as evidenced by the average student learning outcomes for the General Geology course, which is a prerequisite course for Disaster Geography; the control class had an average score of 67.86 for General Geology, and the experimental class had an average score of 66.15.

**Instrument and data collection**

This study used an instrument adapted from Zhang and Cheng. This tool consists of 50 question items that assess disaster literacy. The tool contains three indicators of disaster literacy: awareness (divided into beliefs and discrimination), knowledge, and techniques that represent responders' behaviors and actions (Kanbara et al., 2016; Sung-Chin Chung & Cherng-Jyh Yen, 2016). Before use, the instrument was confirmed to be valid using a validity test. Furthermore, the Cronbach's alpha reliability test revealed a value of 0.628.

Table 2. Disaster Literacy Test Question Indicators

| No | Disaster Literacy Indicators | Sub Indicators |
|---|---|---|
| 1 | Knowledge | Disaster knowledge<br>Job hazards<br>Information for self-defense<br>Evaluation methods and locations<br>Lessons from the past |
| 2 | Attitude | Prevention Awareness<br>Preventive Value<br>Preventive Responsibility |
| 3 | Skills | Preparedness Actions<br>Response Behavior |

**Data Analysis**

Independent sample t-tests were considered appropriate for testing the data in this study, supported by homogeneity and normality tests. Normality was assessed using the Shapiro-Wilk test, with a significance level of 5%. Data analysis was carried out using SPSS version 21 for Windows. The hypotheses tested in this study were as follows.

H0: The level of disaster literacy before and after the implementation of PBL-RCA is the same. H1: There is a difference in the level of disaster literacy before and after implementing PB-LRCA. If the significance value was < 0.05, then H1 was accepted. Otherwise, H1 was rejected.

## RESULTS AND DISCUSSION

**Prerequisite Tests**

Before analyzing the impact of PBLRCA learning on students' disaster literacy skills, normality and homogeneity tests were first conducted. Table 3 shows the results for normality using the Shapiro-Wilk test.

Table 3. Normality Test Results

| Class | Shapiro-Wilk | | |
|---|---|---|---|
| | Statistic value | df | Significance |
| Test | 0.976 | 31 | 0.701 |
| Control | 0.932 | 29 | 0.064 |

(Source: Research Data, 2024)

The normality test p-value for the experimental class was 0.701, and that for the control class was 0.064. Therefore, the literacy skill score data in both classes were usually distributed.

Table 4. Homogeneity Test Results

| Levene Statistics | df1 | df2 | Significance |
|---|---|---|---|
| 0.640 | 1 | 58 | 0.427 |

(Source: Research Data, 2024)

The disaster knowledge scores of the experimental and control classes varied uniformly, as seen in Table 4, which shows a significance level of 0.427 (>0.05) for a Levene statistic of 0.60. Based on the results of the two prerequisite tests, the data had a normal distribution and a homogeneous variance.

**Hypothesis testing**

The impact of the PBLRCA model on disaster literacy was then assessed using independent sample t-tests on the disaster literacy scores (Table 5).

Table 5. Independent Samples t-test Results

| | Q | df | Significance (2-tailed) | Meaningful Difference |
|---|---|---|---|---|
| NGain_persen | 5.787 | 58 | <0.001 | 21.75093 |

(Source: Research Data, 2024)

The data analysis indicated that the significance value for PBL-RCA learning was <0.01. This met the criterion for accepting H1 (i.e., p<0.05). Therefore, there was a significant difference in the level of disaster

literacy before and after the implementation of PBL-RCA learning.

Disaster literacy increased after PBL-RCA was used in learning. As seen in Table 8, the average N-Gain value differed between the pre-and post-test by 9.1 points. The increase in disaster literacy was possible because of the steps and syntax in PBL-RCA learning. There is a slight difference between PBL and PBL-RCA syntax. PBL-RCA is a modification of RCA; the steps are almost the same, but PBL-RCA has two additional steps over the six of PBL. These two steps involve an in-depth problem assessment using RCA and implementing an action plan. The other steps are similar to the usual PBL steps, with slight variations. For example, step 6 is a variation that consists of presenting an action plan to solve the problem.

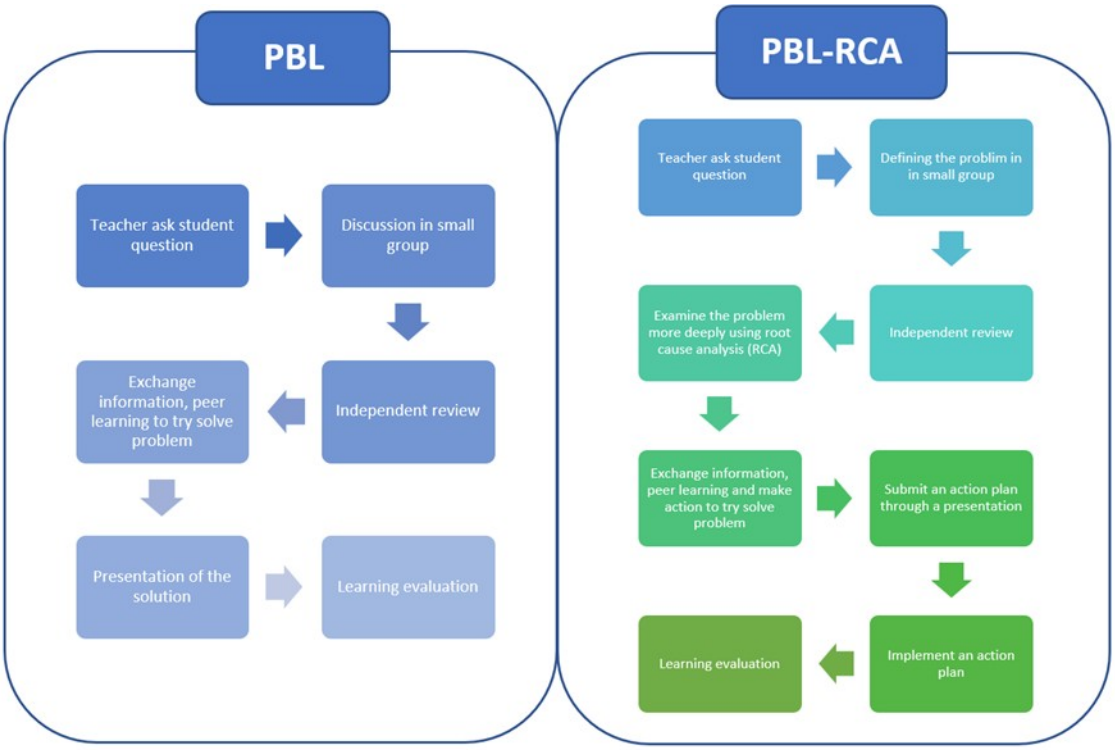


Figure 1. Differences between PBL and PBL-RCA

**Disaster Literacy**

Disaster literacy is expressed in knowledge, attitude, and skills. This includes disaster knowledge, preparedness knowledge, and disaster response knowledge in the knowledge dimension; the values of prevention, responsibility, and awareness in the attitude dimension; and preparedness actions and disaster response behaviors in the skill dimension (Sung-Chin Chung & Cherng-Jyh Yen, 2016).

Chen & Lee (2012) Defined disaster literacy as knowledge, attitudes, and skills. (Chan et al., 2012; Olowoporoku, 2017) Disaster literacy is the ability to identify, understand, interpret, and communicate information related to disaster risk. Disaster literacy is the capacity to read, understand, and use information to make correct decisions when a disaster occurs (Brown et al., 2014; Zhang et al., 2021). Kanbara et al., (2016) Stated that disaster literacy consists of awareness of knowledge and techniques that

help reduce disaster risk. This study used Chen & Lee's definition of disaster literacy, modifying indicators according to Sung-Chin Chung and Cherng-Jyh Yen, as shown in Figure 1.

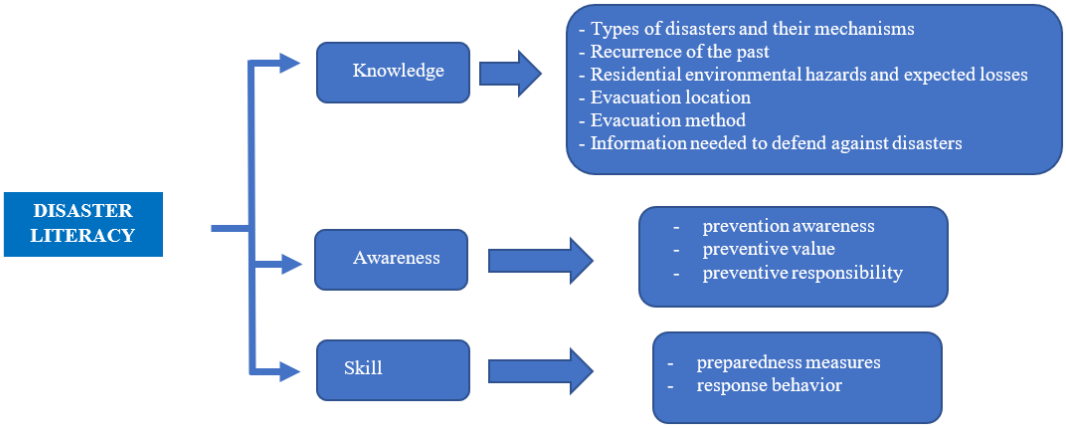


Figure 2. The concept of disaster literacy (Source: Sung-Chin Chung and Cherng-Jyh Yen, 2016)

**The Effect of PBLRCA on Knowledge**

Disaster literacy is measured by measuring the capacity of a person and society to understand, read, and use information to make correct decisions and follow instructions in the context before, during, and after a disaster (Brown et al., 2014). Further, Kanbara et al. stated that disaster risk-reduction literacy will reduce risks that arise through awareness, knowledge, and techniques so that individuals can make decisions quickly when facing disasters (Kanbara et al., 2016). Consistent with this, (Çallşkan & Üner, 2021) provided a definition that referenced the capacity of individuals to make decisions, follow instructions, and utilize information that has been accessed, received, and understood about disaster mitigation, including preparation, response, and recovery to sustain post-disaster life. One of the most influential aspects of such decision-making is knowledge.

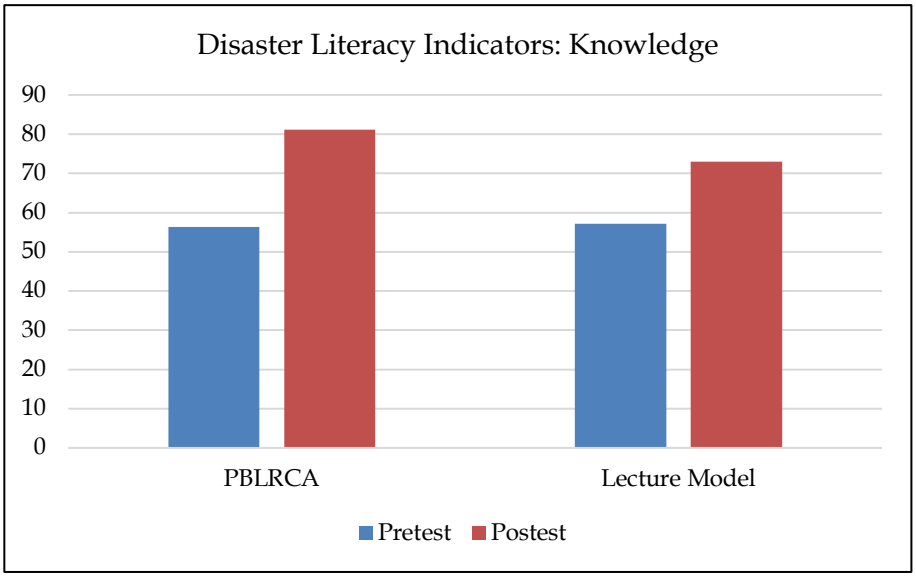


Figure 3. Knowledge Indicator Graph (Source: Research Data, 2024)

The steps and syntax in PBL-RCA learning may influence the increase in knowledge that occurs in students (Figure 3). These steps include defining the problem. Defining problems in small groups makes students study problems with focus. Students search for and read literature relevant to the predetermined theme. Sharing knowledge and ideas increases students' understanding of the problems, spurs the formation of new ideas, and enriches students' intellectual development (Larasati, 2017).

This is strengthened by the next step, namely, an independent review. The problems found are independently reviewed within the group and then explored more deeply in the next step, using RCA. This step allows students to learn about existing issues through literature. Analyzing the root of the problem can strengthen the PBL independent study. Reading the literature in depth in this step indirectly increases students' understanding of PBL (Prabowo et al., 2023). Additionally, students' reading habits and ability to explore problems, combined with reflection, can improve literacy skills (Nurtanto et al., 2020).

Investigating the root of the problem also forces students to gather relevant information to build knowledge (Kanbara et al., 2016; Wajdi et al., 2022). Information-gathering activities teach them to focus on relevant and valid details (Dewi et al., 2022). Individuals investigate data mining and collection issues to determine the best solutions (Suwono et al., 2023).

The analysis process to find formulations and hypotheses based on these problems affects literacy development (Amaringga et al., 2021). Evidence of literacy development can be seen in N-Gain; one of the indicators is knowledge, with a difference of 9.0 points between PBL-RCA and the lecture method.

**The Effect of PBL-RCA on Attitude.**

PBL-RCA has also improved students' attitudes regarding disasters (Figure 4). Building an action plan in PBL-RCA requires surgery and exploration of the problem. The surgery encourages students to actively explore data to develop their knowledge and respond to concerns. This is consistent with (Amin et al., 2020) those who stated that the PBL model can encourage students to actively analyze facts, events, and problems through data collection and discussion to build their knowledge background from start to finish. Appropriate attitudes will develop if individuals understand various information and situations, especially environmental constraints and social safety (Muktaf, 2017). Other research has also shown that PBL affects students' attitudes towards subjects compared to traditional teaching (Abdullah et al., 2010; Günhan & Başer, 2008; Reynolds & Hancock, 2010; Sumarmi, 2012).

Implementing an action plan is another PBL-RCA step believed to improve attitudes towards disasters. Even though the form is simple, implementing an action plan allows students to gain experience. This experience makes students sensitive to the surrounding environment and will enable them to respond positively to problems (Demirel & Dağyar, 2016). The need for further individual involvement in the implementation will foster appropriate attitudes towards the issue (Handoyo et al., 2021; Kasi & Astina, 2017). Attitude in disaster literacy refers to a person who uses their experience to solve problems as a foundation for understanding the aspects and risks of disaster impact management (Brown & Dodman, 2014; Purwanto et al., 2023; Susanto et al, 2016).

Implementing an action plan is a comprehensive step involving applying all the information collected and studied in the previous step. This step increases individuals' response capacity. Preparation, response, and recovery to sustain life after a

disaster involve individuals' capacity to make decisions and follow instructions, utilizing information that has been accessed, received, and understood regarding disaster mitigation (Çallşkan & Üner, 2021).

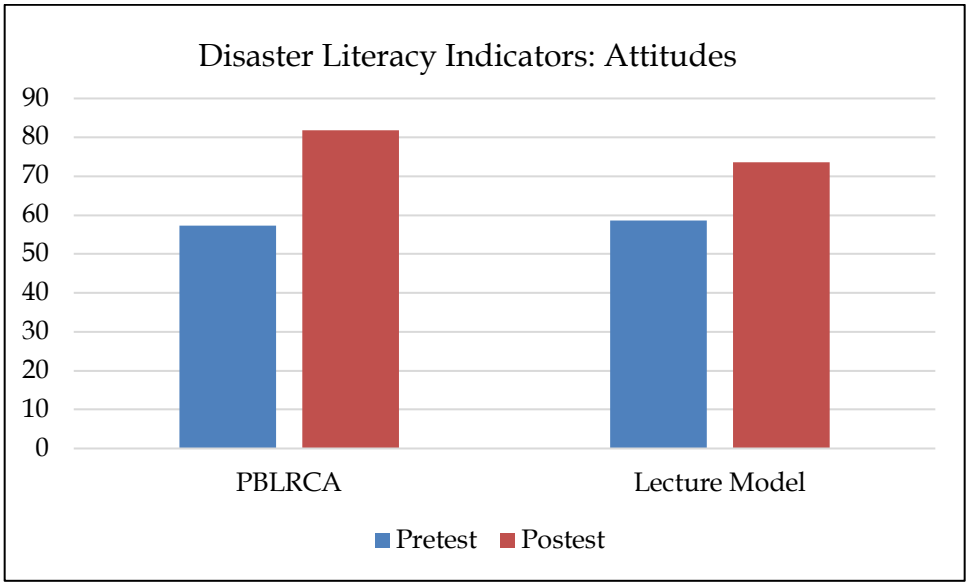


Figure 4. Attitudes Indicator Chart (Source: Research Data, 2024)

**The Effect of PBL-RCA on Skills**

PBL-RCA can improve student skills through habitual problem-solving. This involves skills such as analytical skills, critical thinking, and creativity. In addition to solving problems, analyzing problems from the root cause also accustoms individuals to thinking systematically. This is indispensable in the case of disaster evacuation (Stalker et al., 2015), especially when reading and understanding maps or evacuation routes. The current findings are consistent with prior research (Borhan, 2014; Ahmed et al., 2020). Similarly (Afrian & Islami, 2019) it stated that disaster literacy skills can be supplemented by providing various forms of reading and learning practices, which also help improve literacy skills.

In the fourth PBL-RCA step, students are asked to separate the factors that cause the selected disaster event and the root cause of the disaster. This exploration is critical because by elaborating on these two things, students will find it easier to find the basis of the problem. This is consistent with (Wang et al., 2017) those who stated that students can find various causes and solutions to an observed disaster problem with in-depth study. PBL improves problem-solving skills that allow students to provide informed solutions, and knowledge increases along with the investigative learning process, improving literacy skills (Mundzir & Sujana, 2017; Livingston et al., 2001; Zhang et al., 2021). While applying PBL-RCA in the experimental classroom, students were forced to study the problem by searching the literature to prepare for three meetings. This reading habit allowed students to acquire high-level skills to improve themselves professionally and personally (Dogan et al., 2020). The activity was strengthened by exploring the theme to the root of the problem through literacy studies, direct observation, and interviews in the field. Students carried out this field observation activity during two meetings, during which they sought factors that may differ between theory and actual field conditions. Field observation helps students formulate solutions based on hypotheses. In addition,

RCA is carried out in the form of a direct investigation to identify the root cause of a disaster event (Al-Mamory & Zhang, 2009).

Implementing an action plan is also one of the steps that can improve students' disaster literacy skills in the PBL-RCA learning model. Substantial experience gained directly in the field through observation activities is the foundation for students to develop their thinking skills in solving real problems in the surrounding environment (Priyandari et al., 2020). Implementation activities are believed to increase disaster literacy regarding technical indicators (Ussarn et al., 2022). Students are encouraged to implement the results of their solutions in real life daily or through problem-solving.

PBL-RCA also provides a learning process better to understand the cause and effect of various solutions (Heriwanty, 2021) while influencing a person to make decisions and act (Zheng et al., 2020). The study's results show that PBL-RCA is successful in improving skills. The experimental class that used the model performed better than the control class (Figure 5). The N-Gain score in the experimental class was 22.9, while that in the control class was 14.1.

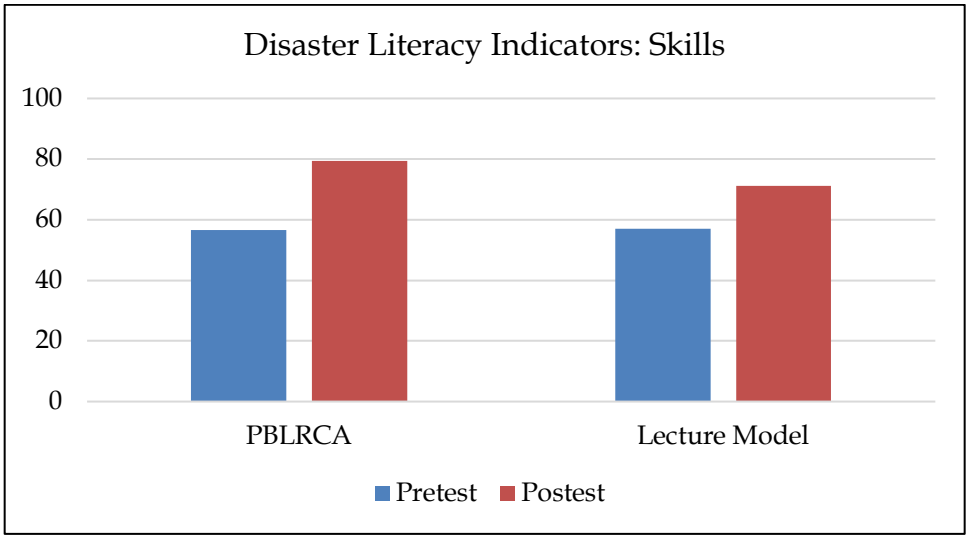


Figure 5. Skills Indicator Chart (Source: Research Data, 2024)

## CONCLUSION

Based on the indicators assessed in this research, including knowledge, attitude, and skills, it can be concluded that PBL-RCA can increase student disaster literacy. This is evidenced by the gain score of the experimental class that used the PBL-RCA learning model, which was higher than that of the control class (Table 6). The increase was due to PBL-RCA measures, which spurred students to read, explore, and improve their experience; this increased the disaster literacy of these students. Researchers should conduct a more in-depth analysis of the variables influencing students' disaster literacy using research methods such as PTK and qualitative methods. In addition, it is hoped that comparative tests with similar learning models will be conducted to determine the effect of the PBL-RCA model on increasing disaster literacy. Disaster management solutions from the learning model could also be applied in disaster risk reduction efforts. Furthermore, the PLRCA model could be used to learn about disaster themes in Indonesia, considering Indonesia is a vulnerable area.

Table 6. Disaster Literacy Values by Learning Model

| Disaster Literacy Indicators | Type | Pre-test | Post-test | N-Gain |
|---|---|---|---|---|
| **Awareness** | PBLRCA | 57.3 | 81.8 | 24.6 |
| | Lecture Model | 58.6 | 73.6 | 15.0 |
| **Knowledge** | PBLRCA | 56.4 | 81.1 | 24.7 |
| | Lecture Model | 57.2 | 72.9 | 15.7 |
| **Technique** | PBLRCA | 56.5 | 79.4 | 22.9 |
| | Lecture Model | 57.1 | 71.2 | 14.1 |

**REFERENCE LIST**

the-based the-based fAbdullah, N. I., Tarmizi, R. A., & Abu, R. (2010). The effects of Problem Based Learning on mathematics performance and affective attributes in learning statistics at form four secondary level. Procedia - Social and Behavioral Sciences, 8(February), 370–376. https://doi.org/10.1016/j.sbspro.2010.12.052

Afrian, R., & Islami, Z. R. (2019). Peningkatan potensi mitigasi bencana dengan penguatan kemampuan literasi kebencanaan pada masyarakat Kota Langsa. Jurnal Pendidikan Geografi, 24(2), 132–144. https://doi.org/10.17977/um017v24i22019p132

Al-Mamory, S. O., & Zhang, H. (2009). Intrusion detection alarms reduction using root cause analysis and clustering. Computer Communications, 32(2), 419–430. https://doi.org/10.1016/j.comcom.2008.11.012

Amaringga, N. G., Amin, M., & Irawati, M. H. (2021). The effect of problem-based learning module containing research result to improve students' scientific literacy. AIP Conference Proceedings, 2330. https://doi.org/10.1063/5.0043529

Amin, S., Utaya, S., Bachri, S., Sumarmi, & Susilo, S. (2020). Effect of problem-based learning on critical thinking skills and environmental attitude. Journal for the Education of Gifted Young Scientists, 8(2), 743–755. https://doi.org/10.17478/jegys.650344

Anurogo, D. (2023, February 15). Diplomasi Literasi Bencana. https://www.antaranews.com/berita/3398031/diplomasi-literasi-bencana

Bashith, A., & Amin, S. (2017). The Effect of Problem Based Learning on EFL Students' Critical Thinking Skill and Learning Outcome. Al-Ta Lim Journal, 24(2), 93–102. https://doi.org/10.15548/jt.v24i2.271

Borhan, M. T. (2014). Problem Based Learning (Pbl) in Teacher Education: a Review of the Effect of Pbl on Pre-Service Teachers' Knowledge and Skills. European Journal of Educational Sciences, 01(01), 76–87. https://doi.org/10.19044/ejes.v1no1a9

Brown, D., & Dodman, D. (2014). Understanding children's risk and agency in urban areas and their implications for child-centred urban disaster risk reduction in Asia. https://www.iied.org/10652iied

Brown, L. M., Haun, J. N., & Peterson, L. (2014). A proposed disaster literacy model. Disaster Medicine and Public Health Preparedness, 8(3), 267–275. https://doi.org/10.1017/dmp.2014.43

Çallşkan, C., & Üner, S. (2021, August 18). Disaster literacy and public health: A systematic review and integration of definitions and models. Disaster Medicine and Public Health Preparedness, Vol. 15, pp. 518–527. https://doi.org/10.1017/dmp.2020.100

Cerniglia-Lowensen, J. (2015). Learning from mistakes and near mistakes: Using root cause analysis as a risk management tool. Journal of Radiology Nursing, 34(1), 4–7. https://doi.org/10.1016/j.jradnu.2014.11.004

Chan, E. Y. Y., Hung, K. C. K., Yue, J., Kim, J. H., Lee, P., & Cheung, E. Y. (2012, April 26). Preliminary Findings on Urban Disaster Risk Literacy and Preparedness in a Chinese Community.

Chandra, W. (2021, March 16). Pentingnya Literasi Kebencanaan di Negeri Rawan Bencana. https://www.mongabay.co.id/2021/03/16/pentingnya-literasi-kebencanaan-di-negeri-rawan-bencana/

Chen, C. Y., & Lee, W. C. (2012). Damages to school infrastructure and development to disaster prevention education strategy after Typhoon Morakot in Taiwan. Disaster Prevention and Management: An International Journal, 21(5), 541–555. https://doi.org/10.1108/09653561211278680

Demirel, M., & Dağyar, M. (2016). Effects of Problem-Based Learning on Attitude: A Meta-analysis Study. Eurasia Journal of Mathematics, Science and Technology Education, 12(8), 2115–2137. https://doi.org/10.12973/eurasia.2016.1293a

Deep, S., Ahmed, A., Suleman, N., Abbas, M., Naza, U., Shaheen, H., & Razzaq, A. (2020). The Problem-Based Learning Approach towards Developing Soft Skills: A Systematic Review. *The Qualitative Report*, *25*(11), 4029-4054. https://doi.org/10.46743/2160-3715/2020.4114

Dewi, C. A., Muhali, M., Kurniasih, Y., Lukitasari, D., & Sakban, A. (2022). The impact of Google Classroom to increase students' information literacy. International Journal of Evaluation and Research in Education, 11(2), 1005–1014. https://doi.org/10.11591/ijere.v11i2.22237

Dogan, B., Yildirim, K., Cermik, H., & Ates, S. (2020). Promoting Pre-Service Teachers' Reading Attitudes through Literature Circles: A Mixed Methods Design. International Journal of Educational Methodology, 6(4), 653–667. https://doi.org/10.12973/ijem.6.4.653

Permendikbud RI No 33 (2019). Program Satuan Pendidikan Aman Bencana. Kementerian Pendidikan dan Kebudayaan (2019).

Fahri Mundzir, M., & Sujana, A. (2017). Problem-Based Learning untuk Meningkat Kemampuan Literasi Sains Siswa SD. Jurnal Pena Ilmiah, 2(1), 421-430. https://doi.org/10.17509/jpi.v2i1.10677

Cantürk-günhan, B., Cantürk Günhan, B., & Başer, N. (2009). Probleme Dayalı Öğrenmeye İlişkin Öğrenci, Öğretmen Ve Öğretim Üyelerinin Görüşleri. Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 3(1), 134-155.

Handoyo, B., Astina, I. K., & Mkumbachi, R. L. (2021). Students' environmental awareness and pro-environmental behaviour: Preliminary study of geography students at state university of malang. IOP Conference Series: Earth and Environmental Science, 683(1). https://doi.org/10.1088/1755-1315/683/1/012049

Heriwanty. (2021). Pentingnya Root Cause Analysis dalam Peningkatan Mutu Sekolah. https://bpmpsulteng.kemdikbud.go.id/pentingnya-root-cause-analysis-dalam-peningkatan-mutu-sekolah/

Hosnan, M. (2014). Pendekatan saintifik dan Kontekstual Dalam Pembelajaran Abad 21 (2nd ed.). Bogor: Ghalia Indonesia.

Ilham, B. U. (2022, May 16). Harbuknas 2022 : Literasi Indonesia Peringkat Ke-62 Dari 70 Negara. https://bisniskumkm.com/harbuknas-2022-literasi-indonesia-peringkat-ke-62-dari-70-negara/

Kanbara, S., Ozawa, W., Ishimine, Y., Ngatu, N. R., Nakayama, Y., & Nojima, S. (2016). Operational definition of disaster risk-reduction literacy. Health Emergency and Disaster Nursing, 3(1), 1-8. https://doi.org/10.24298/hedn.2014-0016

Kasi, K., & Astina, I. K. (2017). Pengaruh Model Pembelajaran Service Learning terhadap Sikap Peduli Lingkungan. Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan 3(4). http://dx.doi.org/10.17977/jptpp.v3i4.10733

Kum, S., & Sahin, B. (2015). A root cause analysis for Arctic Marine accidents from 1993 to 2011. Safety Science, 74, 206–220. https://doi.org/10.1016/j.ssci.2014.12.010

Larasati, D. A. (2017). Pengaruh Model Problem-Based Learning terhadap Kemampuan Pemecahan Masalah Geografi SMA. Jurnal Geografi, 9(1), 6–18. https://doi.org/10.24114/jg.v9i1.6045

Livingston, A., Jackson, G., & Priestley, K. (2001). Root Causes Analysis : Literature Review. HSE Contract Research Report .

Ma, Q., Li, H., & Thorstenson, A. (2021). A big data-driven root cause analysis system: Application of Machine Learning in quality problem solving. Computers and Industrial Engineering, 160. https://doi.org/10.1016/j.cie.2021.107580

Muktaf, Z. M. (2017). Studi Literasi Bencana dalam Perspektif Ilmu Komunikasi. Retrieved on December, 13, 2018.

Nurtanto, M., Fawaid, M., & Sofyan, H. (2020). Problem Based Learning (PBL) in Industry 4.0: Improving Learning Quality through Character-Based Literacy Learning and Life Career Skill (LL-LCS). Journal of Physics: Conference Series, 1573(1). https://doi.org/10.1088/1742-6596/1573/1/012006

Olowoporoku, O. A. (2017). Assessment of Households' Disaster Management Literacy in Osogbo, Nigeria. Retrieved from https://www.researchgate.net/publication/319094437

Pham, J. C., Kim, G. R., Natterman, J. P., Cover, R. M., Goeschel, C. A., Wu, A. W., & Pronovost, P. J. (2010). Recasting the RCA: An improved model for performing root cause analyses. American Journal of Medical Quality, 25(3), 186–191. https://doi.org/10.1177/1062860609359533

Prabowo, A., Suparman, S., Li, C. S., Janan, D., & Damayanti, T. D. (2023). The effect of reading literacy to mathematics comprehension of elementary school students in Indonesia and Malaysia. International Journal of Evaluation and Research in Education, 12(1), 546–554. https://doi.org/10.11591/ijere.v12i1.25714

Purwanto, Hidayah, N., & Wagistina, S. (2023). The Effect of Gersmehl's Spatial Learning on Students' Disaster Spatial Literacy. International Journal of Educational Methodology, 9(2), 345–354. https://doi.org/10.12973/ijem.9.2.345

Reynolds, J. M., & Hancock, D. R. (2010). Problem-based learning in a higher

education environmental biotechnology course. Innovations in Education and Teaching International, 47(2), 175–186. https://doi.org/10.1080/14703291003718919

Saregar, A., Sunyono, Haenilah, E. Y., Hariri, H., Putra, F. G., Diani, R., … Umam, R. (2022). Natural Disaster Education in School: A Bibliometric Analysis with a Detailed Future Insight Overview. International Journal of Educational Methodology, 8(4), 743–757. https://doi.org/10.12973/ijem.8.4.743

Sari, Y. I., Sumarmi, Utomo, D. H., & Astina, I. K. (2021). The Effect of Problem Based Learning on Problem Solving and Scientific Writing Skills. International Journal of Instruction, 14(2), 11–26. https://doi.org/10.29333/iji.2021.1422a

Stalker, S. L., Cullen, T. A., & Kloesel, K. (2015). Using PBL to prepare educators and emergency managers to plan for severe weather. Interdisciplinary Journal of Problem-Based Learning, 9(2). https://doi.org/10.7771/1541-5015.1441

Suharini, E., Meliana, D., Sanjoto, T., & Kurniawan, E. (2020, January 9). The Strategy of Disaster Mitigation Literacy through Problem-Based Learning (PBL) in the School Prone to Tidal Floods. https://doi.org/10.4108/eai.18-7-2019.2290156

Sumarmi. (2012). Model-Model Pembelajaran Geografi. Malang: Aditya Media Publishing.

Sung-Chin Chung, & Cherng-Jyh Yen. (2016). Disaster Prevention Literacy among School Administrators and Teachers: A Study on the Plan for Disaster Prevention and Campus Network Deployment and Experiment in Taiwan. Journal of Life Sciences, 10(4). https://doi.org/10.17265/1934-7391/2016.04.006

Suparya, I. K., I Wayan Suastra, & Putu Arnyana, I. B. (2022). Rendahnya Literasi Sains: Faktor Penyebab Dan Alternatif Solusinya. Jurnal Ilmiah Pendidikan Citra Bakti, 9(1), 153–166. https://doi.org/10.38048/jipcb.v9i1.580

Susanto, A., Sumarmi, ., & Susilo, S. (2016). Improving Natural Disaster Mitigation and Adaptation Using Geographic Literacy. Mediterranean Journal of Social Sciences. https://doi.org/10.5901/mjss.2016.v7n6p333

Suwono, H., Permana, T., Saefi, M., & Fachrunnisa, R. (2023). The problem-based learning (PBL) of biology for promoting health literacy in secondary school students. Journal of Biological Education, 57(1), 230–244. https://doi.org/10.1080/00219266.2021.1884586

Tim Penyusun Naskah Akademik Universitas Syiah Kuala. (2019). Rancangan Qanun Aceh tentang Pendidikan Kebencanaan.

Ussarn, A., Pimdee, P., & Kantathanawat, T. (2022). Needs assessment to promote the digital literacy among students in Thai community colleges. International Journal of Evaluation and Research in Education, 11(3), 1278–1284. https://doi.org/10.11591/ijere.v11i3.23218

Vinta. (2023, January 4). Literasi Bencana Dianggap Masih Rendah di Lapisan Masyarakat. https://www.rri.co.id/lain-lain/127200/monitoring-literasi-bencana-dianggap-masih-rendah-di-lapisan-masyarakat

Wajdi, M., Jamaluddin, A. Bin, Nurdiyanti, N., & Magfirah, N. (2022). The effectiveness of problem-based learning with environmental-based comic in enhancing students

environmental literacy. International Journal of Evaluation and Research in Education, 11(3), 1049–1057. https://doi.org/10.11591/ijere.v11i3.22140

Wang, G., Briskot, T., Hahn, T., Baumann, P., & Hubbuch, J. (2017). Root cause investigation of deviations in protein chromatography based on mechanistic models and artificial neural networks. Journal of Chromatography A, 1515, 146–153. https://doi.org/10.1016/j.chroma.2017.07.089

Ware, K., & Rohaeti, E. (2018). Penerapan Model Problem Based Learning dalam Meningkatkan Kemampuan Berfikir Analitis dan Keterampilan Proses Sains Peserta Didik SMA. JTK (Jurnal Tadris Kimiya), 3(1), 42–51. https://doi.org/10.15575/jtk.v3i1.2219

Yuniar Priyandari, T., Astina, I. K., & Utomo, D. H. (2020). Pengaruh Model Pembelajaran Experiential Learning terhadap Kemampuan Pemecahan Masalah Mahasiswa Geografi. Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan 5(1). http://dx.doi.org/10.17977/jptpp.v5i1.13117

Zhang, D., Zhu, X., Zhou, Z., Xu, X., Ji, X., & Gong, A. (2021). Research on Disaster Literacy and Affecting Factors of College Students in Central China. Disaster Medicine and Public Health Preparedness, 15(2), 216–222. https://doi.org/10.1017/dmp.2020.33

Zheng, M., Marsh, J. K., Nickerson, J. V., & Kleinberg, S. (2020). How causal information affects decisions. Cognitive Research: Principles and Implications, 5(1). https://doi.org/10.1186/s41235-020-0206-z