



The Implementation of Strain Liquefaction Learning Package to Cultivate the Critical Thinking of High School Students



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ABSTRACT

This study aims to explain the potential of liquefaction in Padang Lekat Village and Pasar Ujung Village Kepahiang District, explaining the feasibility of developed learning packages, and explaining students' critical thinking skills after learning the wave material through the learning package "Strain Liquidity Learning". The type of study used was research and development which aims to develop digital-based physics learning packages that are integrated with disaster mitigation education on the basic competencies of waves in high school education units. This research was conducted using ADDIE development research procedures. The results of research on the analysis of liquefaction potential based on microtremor data using the Ground Shear Strain method, zoning indication of liquefaction potential due to geological conditions and seismic potential, generally Padang Lekat Village and Pasar Ujung Kepahiang Village are areas that have no potential to experience liquefaction. However, there are a number of locations indicated by potential liquefaction, although not significantly. Learning Package Book "Learning Liquid Strain" compiled based on the analysis of liquefaction potential based on expert validation is appropriate to be used as a learning medium for seismic and liquefaction waves. In its application with distance learning, the compiled learning package book has been able to improve critical thinking skills in students even though the N-gain improvement obtained is still in the low and medium categories.

Keywords: Liquefaction, Learning Packages, Critical Thinking, Wave.

Introduction

Physical learning is directly associated with the natural environment and studies of natural phenomena as matter and forms of energy and as the relationship between them (Kanginan, 2013). It is in line with the many disasters phenomenon that exist in students' environment or Indonesia on a larger scale. As one of the countries through which the ring of fire lies between the three tectonic plates of the world, Indonesia is a country prone to many catastrophes, including the Bengkulu province.

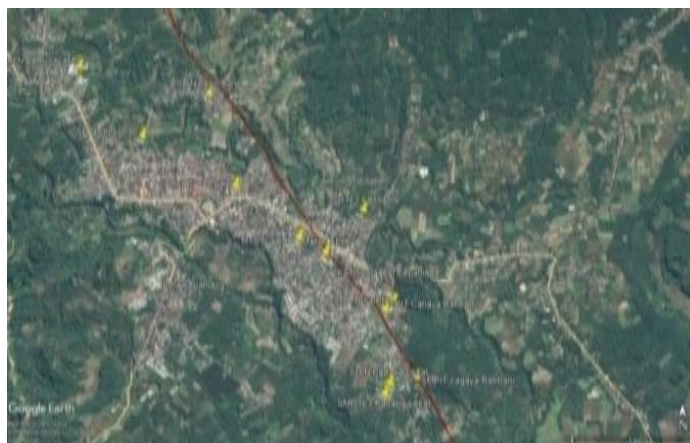


Figure 1. Photo of the Musi Segment Fault that crosses Kepahiang City (BMKG, 2017)

Bengkulu Province is a disaster-prone area especially geological disaster due to its position which is located in the western part of Sumatra Island which is in the subduction zone of the Indo-Australian Plate and the Eurasian Plate. The movement produced by the collision of the two plates created the formation of active faults in the western part of Sumatra, the Semangko Fault and the Mentawai Fault that passed through Bengkulu Province. One of the active cesarean branches across Bengkulu is a segment of Musi located in Kepahiang District. The existence of the Musi segment make its path areas such as Sub Kepahiang especially those Padang Lekat and Pasar Ujung village are vulnerable to the earthquake and the potential for liquefaction.

Kepahiang Regency has a history of seismicity with a fairly high intensity scale. One of them is an earthquake that occurred on December 15, 1979 with a magnitude of 6.0. Furthermore, the conclusion is that the region of Musi segments has a remover period with a magnitude, $M > 6.0$ on average every 19 years, $M > 5.0$ average every 8 years once, $M > 4.0$ on average every 3 years, $M > 3.0$ on average every 1 year, and $M > 2.0$ on average every 0.5 years (Ardiansyah, 2016).

Given that potential, a lot of research has been done with the pensive analysis in Kepahiang. However, the threat of soil movement as a popular effect like liquidation is rarely examined. The liquefaction itself is a process or occurrence of a shift in the soil from solid to liquid state, as a result of alternating force (dynamic cyclic) from earthquake waves (Kusuma et al, 2014). Liquidity is results when the saturation of the water is caused by strong, cyclic (repeated regularly) soil caused by an earthquake, causing pore pressure to rise near or beyond vertical pressures. Although, according to the Day (in suhartini, 2019), the liquidity disaster still allows cohesive ground conditions, so in high terrain such as Kepahiang still has the potential for liquidation. This is in view of the potential for earthquakes especially high ground quakes in this location. Liquidation events can cause, collapse, tilting in buildings, ground cracking, case (subowo et al, 2014).

The liquidity as a geological threat needs attention from all sectors of government, one of which is education. In the education sector, one of the processes of transfer of knowledge and understanding about the liquidity natural disasters in learners is through digital based learning packages that integrate potential liquidity disasters in basic competence of waves. The integration of the liquidity catastrophe in the physics study will be a learning package and to tackle one of the problems of science-learning that it is a belief in learners that the science lesson in physics in particular is difficult to understand. The emergence of this assumption is partly because of insufficient contextual study of physics. The emphasis on understanding these basic concepts and basic notions of science is not linked to those relating to everyday life, including the natural phenomenon of disaster.

Contextual learning as part of education also plays an important role in preparing learners who have scientific literacy capabilities, which are capable of critical, creative, logical thinking, and taking the initiative in addressing issues in society that result from the effects of scientific and technological development. Specifically in the critical aspect of thinking, according to the constructive theory of vism, piaget states that when one builds one's knowledge, it takes a greater balance of learning to form an effective cognitive contact or conflict between the old concepts and a new reality (Setyowati et al, 2011). Cognitive conflict stimulation in learning will greatly help the process of assimilating to be more effective and meaningful in students' intellectual struggles. With critical thinking ability, students continue with concept understanding of the material, will make students' cognitive learning optimized (setyowati et al, 2011).

Critical thinking ability is a person's ability to use his thinking process independently and logically in weighing, analyzing, evaluating, or interpreting an argument that aims to make a decision about what he believes in and what he will do. As for facione's critical thinking indicator is an interpretation, analysis, evaluation, inference, explanation and self-regulation such as the following diagram,

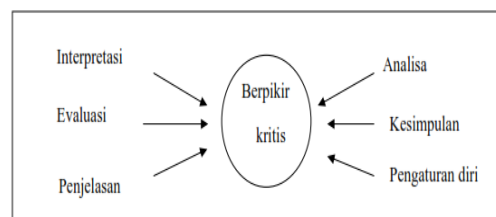


Fig 2. Critical Thinking Ability Chart

Hence, as far as the facts are concerned, a study of the implementation of a learning media package of

learning in a study of physics based on analysis of the potential liquidity to explain the potential for liquidity in the veld and the end market life of the heroic district would be conducted. The study also explains the worthiness of the developed learning package and explains the critical thinking ability of learners after studying seismic and liquefaction materials through the learning package.

RESEARCH METHODS

This research method is *research and development* which is aimed at developing the digital-based physics study package integrated with the liquidity disaster mitigation education on basic wave competence in the high school school. This study is conducted by using the ADDIE development research procedure developed by Robert maribe branch a five-step model: 1) analyze, 2) design, 3) development, 4) implementation, and 5) evaluation.

This research was conducted in Padang Lekat village and Pasar Ujung village for Analysing of liquidation potential in Kepahiang and carried out in senior high school number 4 and 5 Kepahiang Regency for implementating of packages in physics learning based on offline and online modes. The time of research development is carried out for ± 7 months, from December 2019 to June 2020. The time of the study is determined by considering the semester course in physics subject which contains wave material. The steps taken in this research are:

- 1) Analyze phase is in the form of observation and to find out the potential and problems that support this research.
- 2) The second stage is design. At this stage, the researchers conducted a study by analyzing the liquefaction potential in Padang Lekat Village and Pasar Ujung Village by using the method of using Ground Shear Strain (GSS) values based on microtremor surveys. The results of the analysis of potential liquefaction in packaging in digital-based learning packages entitled "Learning Liquidity Strains". The Learning Package products compiled on a manual and digital basis outline contain Wave material, Seismic Wave material, Liquidation material, and liquefaction learning strategies. Digital format learning package created using the Sigil ePUB application.
- 3) The third stage is development. At this stage the product draft is developed, the preparation of assessment instruments to measure students' critical thinking skills as well as instruments to see the feasibility of the learning package. At the develop stage, expert validation was also carried out by physical education experts, liquefaction experts, seismic wave experts, and learning media experts.
- 4) The next stage is the implementation phase with Limited Trials as a form of limited dissemination. The subject of the Limited Trial is 15 students. The research design used in the Limited Trial is one group pretest posttest design (experimental design). The data obtained in the form of the results of the pretest and posttest. After obtaining the results of the Limited Tryout, an evaluation of the quality of the learning package was arranged. The quality of the learning package can be determined by using benchmarks for each data.

The data obtained is then analyzed. Data analysis techniques adapted to the type of data. The results of critical thinking skills tests on students were analyzed by analyzing data on the ability to think critically based on the calculation of Normalized gain (N-gain). The N_{gain} score obtained is used to see an increase in critical thinking skills from before being treated and after being treated. The scores are grouped in the following categories as in Table 1 below,

Table 1. Classification of N_{gain}

N_{gain} acquisition category	Description
$0,70 > N_{gain}$	High
$0,30 \leq N_{gain} \leq 0,70$	Medium
$N_{gain} < 0,30$	Low

While the validation data from the validator to the Learning Package are analyzed with an average score and categorized based on the following Table 2;

Table 2. Qualification of Learning Tools Assessment

Achievement Stage (100%)	Qualification	Description
81-100	Very decent	No revision needed
61-80	Worthy	No revision needed
41-60	Decent enough	Revision
21-40	Inadequate	Revision
0-20	Very Inadequate	Revision

RESULTS AND DISCUSSION

Analysis of Potential Liquefaction in Kepahiang

Microtremor data obtained in this study were recorded in the form of ground vibration data in the H / V curve time function, which then interpreted the results as dominant frequency (f_0) and wave amplification (A_0) amplification and wave parameters indicating the condition of the soil layer as one of the factors that affect a location have the potential for liquefaction or not. The distribution of the dominant frequency and amplification values at the study location is shown as Figure 3 and Figure 4 below,

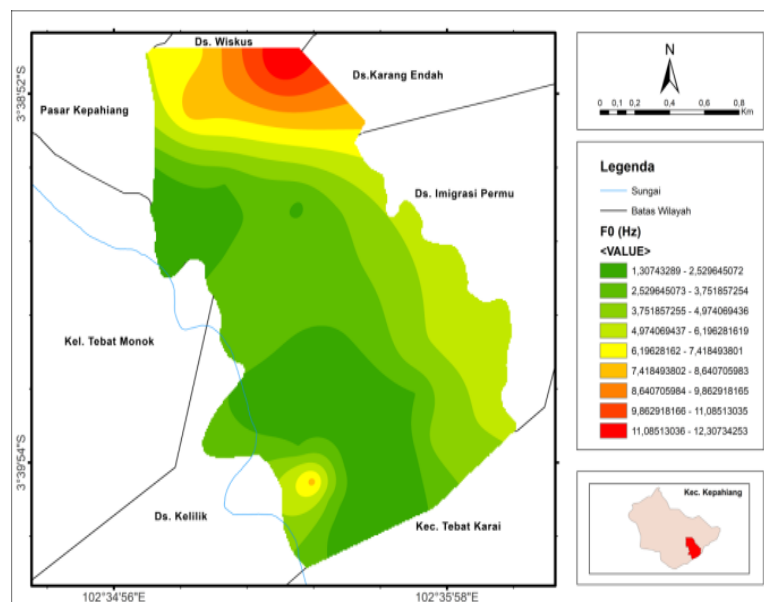


Figure 3. Frequency Value Distribution Map in Padang Lekat and Pasar Ujung Subdistrict

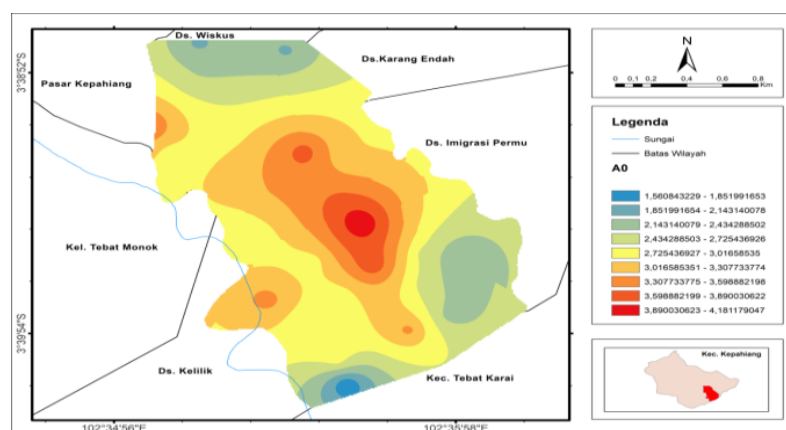


Figure 4. Amplification Value Distribution Map in Padang Lekat and Pasar Ujung Subdistrict

Generally, based on the dominant frequency values, the characteristics of the Padang Lekat and Pasar Ujung sub-districts consist of alluvium rocks which are very vulnerable to earthquakes and are indicated to have the potential for subsequent disasters such as liquefaction. In addition, the region has a high enough amplification value so that it can amplify vibrations during earthquakes. The amplification value and dominant frequency data are processed so that the seismic vulnerability index value and the maximum ground acceleration value are further processed so that the Ground Shear Strain (GSS) value is obtained. According to the theory of Isihara (in Farid etc, 2014), shear strains will trigger deformation in the surface soil layer. Liquefaction deformation will occur if the shear strain value is greater than 1×10^{-3} . Then based on the GSS values obtained in the study, obtained 6 research location points indicated a potential for liquefaction although not significant as shown in table 3 below,

Table 3. Zoning Indications of Potential Liquidation in Padang Lekat and Pasar Ujung village

Research Point	Coordinate		GSS Value (earthquake)
	Long ($^{\circ}$)	Lat ($^{\circ}$)	
T-02	102,584	-3,651	$1,276 \times 10^{-3}$
T-10	102,590	-3,663	$1,097 \times 10^{-3}$
T-14	102,592	-3,653	$1,251 \times 10^{-3}$
T-18	102,597	-3,665	$1,242 \times 10^{-3}$
T-24	102,595	-3,661	$1,101 \times 10^{-3}$
T-25	102,595	-3,658	$1,178 \times 10^{-3}$

Based on table 3, the zonation is an indication of the potential liquefaction caused by geological conditions and the potential for seismicity, generally Padang Lekat Village and Kelurahan Ujung Kepahiang are areas that are indicated to have no potential to experience liquefaction. However, there are a number of locations that indicate potential liquefaction, although not significant.

Digital Learning Package Book

The product in this study is a learning package with the title "Strain Liquidity Learning" which contains guidelines for teachers in presenting learning about waves and their application to liquefaction events as well as guidelines for students in learning. This product is validated to test the feasibility of the product according to the material experts and instructional media experts. Validation from material experts and media experts produce conclusions as in table 4 and table 5 below;

Table 4. Results of Material Validation by Validators

Validators' Name	Score	Criteria	Description
AD	84,38	Very good	Worthy
LZM	76,56	Good	Worthy
SA	90,63	Very good	Worthy

Table 5. Results of Media Validation by Validators

Validators' Name	Score	Criteria	Description
HT	84,62	Very good	Worthy

From this table, the Learning Package Book "Learning Liquid Strains" was concluded to be feasible to use referring to the percentage descriptive technique with the formula according to Sudjiono (Perdana, 2013), the product validation score in the range of 82% - 100%, was declared very feasible to use and in the range of 63 % - 81% are declared eligible.

Limited Trial Results Measure of Critical Thinking Ability

Learning Package "Strain Liquidity Learning" is implemented in distance physics learning with the research design used is one group pretest posttest design (experimental design. Data collection methods the

data collected in this research measure critical thinking skills are quantitative data. Quantitative data in the form of pretest data and posttest in the form of a score of critical thinking skills essay questions. The result quantitative pretest and posttest data from respondents as following,

Table 6. Results of Pretest and Posttest Critical Thinking Ability Tests

Parameter	Pretest Result	Posttest Result	N-Gain score
The lowest score	10	16	
The highest score	47	62	
Median	17,24	33,62	
Average	22,91	36,45	0,2
Standard Deviation	11,64	12,30	
Number of Respondents	14	14	

The pretest and posttest results are then analyzed based on aspects of critical thinking skills with the following results:

Table 7. The Aspects of Critical Thinking Skills Achievements

Aspects of Critical Thinking Skills	Average of Pretest Results	Average of Posttest Results	N-Gain Score
Interpretation	24	35	0,1
Analysis	16	41	0,3
Evaluation	8	39	0,3
Inference	53	61	0,2
Explanation	5	8	0,0
Self-Regulation	56	65	0,2
Average	27	41	0,2

In table 6, the pretest results of the respondents obtained an average value of 22.91 while the posttest results of 36.45. The value of N-gain increased the results of critical thinking skills obtained by 0.2 which means an increase in critical thinking skills after being given the treatment of distance learning using the Digital Learning Package Book "Strain Liquidation Learning" is relatively low. While based on Table 7, an increase in the achievement of critical thinking aspects at the pretest and posttest obtained an increase in N-gain value after being given a treatment of 0.2 which is relatively low. When viewed in every aspect, N-gain with the medium category is found in the aspects of analysis and evaluation, while in the aspects of interpretation, inference, explanation, and self regulation, the N-gain value is in the low category.

However, it's possible for each of the respondents to have a general increase in critical thinking ability as well as in every aspect of critical thinking ability. This suggests that learning can improve the results of learning in critical aspect of thinking ability is consistent with the Piaget theory in which high school students are already in the formal operating stages called proportional thinking (Sit, 2012). At this time, children are capable of high levels of thought, such as deductive, inductive, analyzing, synthesizing, abstract, reflective thinking, and solving problems. However, in application it requires effective learning treatment in order to generate a high critic thinking ability in students. Therefore, it's not significant that the improvement of critical thought results in students is due to the extent of some of the learning components given to students.

According to some previous research that has been done, there are several components that must be performed on learning to improve students' critical thinking ability. This research is done by via cognitive conflict in an effort to improve critical thinking ability in students. In the study, in an effort to improve critical thinking ability, it required an effective cognitive contact or conflict between old concepts and new

realities according to the construction theory developed by the Piaget (Setyowati et al, 2011). In application, the process of assimilation and accommodation in the process of cognitive conflict involves three stages: (a) preliminary (preliminary) involving the presentation of cognitive conflict, (b) the creation of conflict with the aid of demonstration or experiment involving the process of assimilation and accommodation, (c) resolution: discussion activities and conclusion of discussion. Learning that meets all three stages is expected to be able to improve high level thinking ability in students including critical thinking ability.

In this paper, a product that has been designed is a product that already supports the cognitive conflict of instruction for demonstration or experiment activities and discussion manuals and summarizes the results of such discussions as those found in the "liquefaction learning strain" of the package book, section iii of the learning strategy. The study is designed to connect students' initial understanding of the wave and its application to the new concept of seismic impact and liquefaction disaster. However, in application of the several steps such as demonstration and experimentation cannot be carried out because there is no face-to-face study and independent inquiry still is not possible. It means that the presentation of cognitive conflict to the given teaching is not fully executed on the process of creating cognitive conflict to its completion. This will affect the understanding of students and will certainly result in one aspect of students' learning such as critical thinking ability.

Additionally, the teaching materials presented also involve information technology assistance in developing critical concepts and thinking ability on abstract physical concepts. The information technology presented is applied to multimedia interactive forms of digital learning media. Hence, a low value gain increases critical thinking ability in research conducted by researcher could be due to some possible causes, are:

- 1) Students as respondents are still not accustomed to independent learning and are still not too familiar with teaching materials in the form of digital.
- 2) Editor of the "Strain Liquidity Learning" Package which the author conveys to students has not been able to fully direct students to practice critical thinking skills. Students still have old concepts and will be difficult to change if only through online learning, so more detailed information is needed about the material both in writing and oral explanation.
- 3) In online learning, students are required to study more independently. The results of a study about the relationship between attitudes of independence with student learning achievement, found that the lack of good attitude of learning independence owned by students indicates the lack of student initiative in learning, the lack of student discipline in learning, the lack of self-confidence students in learning, as well as the lack of student responsibility in learning (Saefullah et al, 2013). In distance learning, teachers will find it difficult to control student discipline and responsibility in learning.
- 4) The learning presentation that is displayed in the "Learning Liquidity Strain Package Book" is still too difficult considering liquidity is a new phenomenon that is the concern of many parties. The difficulty of the material will certainly affect learning outcomes. The low learning outcomes of students Physics, one of which is caused by the material on the learning media that is too difficult to follow.

CONCLUSIONS

Based on the results of research and discussion, it can be concluded that:

- 1) Based on microtremor data in the form of seismic wave dominant frequency data and wave amplification, by using the Ground Shear Strain method, zonation is indicative of liquefaction potential caused by geological conditions and seismic potential, generally Padang Lekat Village and Ujung Kepahiang Kelurahan are areas that are affected by geological conditions. indicated no potential to experience liquefaction. However, there are a number of locations that indicate potential liquefaction, although not significant.
- 2) Learning Package Book "Learning Liquid Strains" compiled properly used as a medium of learning seismic waves and liquefaction.
- 3) Distance learning using the "Strain Liquidity Learning" Learning Package Book has been able to improve students' critical thinking skills even though the improvement gained has not been significant.

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