

## Microtremor Data to Strengthen the Students' Mastery of Materials in the Implementation of Integrated Physics Learning

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### Abstract

*A geophysical research has been conducted to determine the level of hazard vulnerability in West Halmahera by using microtremor data. Microtremor data are analyzed using the Horizontal to Vertical Spectral Ratio (HVSr) method and it is processed using Geopsy software to know hazard vulnerability level in the region. Data analysis and processing are used as sources of information in physics learning materials using an integrated learning model. Research objectives are to train the students to understand the materials in the fields of study and to enhance other discovery ideas. This research method uses the correlational method and the type of research is experimental research. The research design is an unique case research design and the instrument used is tests and questionnaires. The results of this research indicate that the microtremor data using integrated learning models of integrated types have effect on the students' Mastery of materials in the implementation of physics learning. The effect of the integrated learning model of integrated type on the students' Mastery of materials on the concepts of vibration and waves is 16% and it is in low category. Whereas, the students' responses to integrated learning model of integrated type are quite fun and it can help to improve their mastery of the material on the concepts of vibration and waves.*

**Keywords:** *microtremor; lesson; integrated model*

## Penggunaan Data Mikrotremor Terhadap Penguasaan Materi Siswa Dalam Implementasi Pembelajaran Fisika Terintegrasi

### Abstrak

Penelitian sains telah dilakukan untuk mengetahui tingkat kerentanan bahaya gempabumi dengan menggunakan data mikrotremor. Data mikrotremor di analisis menggunakan metode Horizontal to Vertical Spectral Ratio (HVSr), dan diolah menggunakan software Geopsy sehingga diketahui nilai tingkat kerentanan bahaya gempabumi. Hasil penelitian dari data mikrotremor akan dijadikan sumber informasi yang terintegrasi ke dalam materi pembelajaran fisika dengan menggunakan model pembelajaran terpadu tipe Integrated. Tujuan penelitian ini adalah untuk melatih siswa agar memiliki pemahaman dalam penguasaan materi antar bidang studi dan meningkatkan ide-ide penemuan lain. Metode penelitian ini menggunakan metode korelasional dan jenis penelitiannya adalah eksperimental. Desain penelitiannya adalah desain penelitian one-shot case study dengan instrumen yang digunakan adalah soal tes dan angket. Hasil dari penelitian ini adalah terdapat pengaruh penggunaan data mikrotremor dengan menggunakan model pembelajaran terpadu tipe Integrated terhadap penguasaan materi siswa dalam implementasi pembelajaran Fisika, dan besar pengaruh model pembelajaran terpadu tipe Integrated terhadap penguasaan materi siswa pada konsep getaran dan gelombang adalah sebesar 16% dan termasuk kategori rendah. Sedangkan untuk respon siswa terhadap model pembelajaran terpadu tipe Integrated adalah cukup menyenangkan dan dapat membantu meningkatkan penguasaan materi pada konsep getaran dan gelombang.

**Kata Kunci:** mikrotremor; pembelajaran; model integrated

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## I. INTRODUCTION

West Halmahera has a high level of risk for earthquake disasters. According to data from the North Maluku Regional Disaster Management Agency (BPBD), in 2015, many earthquake events occurred in West Halmahera, especially in Bobanehena Village. Damage to buildings is very significant to the community's economy, although there were no fatalities. In addition, the risk also occurs on damage to soil structures that support the buildings above it, such as settlement, rockfall, landslide, slope stability, and liquefaction [1,2].

The level of earthquake hazard vulnerability can be known using microtremor data with a set of TDS-303 seismometer devices. The level of earthquake hazard vulnerability in West Halmahera can be used as an effort to mitigate earthquakes. One of the efforts to mitigate natural disasters is through learning and education [3]. Knowledge about natural disasters needs to be taught to students as the essential knowledge for prevention and action to minimize damage [4].

The Minister of Education and Culture (2010) states that students are members of the community vulnerable to natural disasters. If students' area is one of the disaster-prone areas,

students will feel that the event is closely related to the material they are going to study [5].

The research results on the students' responses to the integrated learning model were positive [5]. The results of the implementation of microtremor data on physics learning show that students' cognitive learning outcomes have increased in medium criteria [6].

The results of observations conducted at SMK Negeri 1 West Halmahera reveal that the teachers do not apply the Integrated learning model, so that the students' mastery of physics material, especially the concept of Vibrations and Waves, is still relatively low.

The curriculum and role of the teacher significantly affect learning. Integrated learning strongly encourages students to develop skills such as effective communication, problem-solving, independent learning, and information sharing [7]. In addition to the curriculum and the teacher's role, teaching materials play an essential part in learning to make learning more interesting, practical, realistic, and meaningful [8]. Teaching material is the teacher's aid to transfer knowledge and skills to students so that the student competencies such as knowledge and skills will be increased [9]. The curriculum and teachers' abilities in teaching are very influential.

According to Fogarty, the integrated model is integrated learning that uses an interdisciplinary approach to study, combining fields of study by setting curricular priorities and finding overlapping skills, concepts, and attitudes in several fields of study [10]. The learning tools used in the Integrated learning model are the syllabus, lesson plan, and learning media. The integrated learning model of integrated type aims to train students to understand the material in the fields of study and enhance other discovery ideas.

The integrated learning model of integrated type can improve mastery and develop thinking skills in understanding one concept to another to solve problems in real life [11]. The integrated learning model is an approach which used students' to describe the interrelationships between sub disciplines of science such as biology, chemistry, physics, and earth/space science [12]. However, it has a weakness because it requires an interdepartmental team with the same planning and teaching time.

The integrated learning model of integrated type is often seen as a way to effectively approach 21st century learning with that uses an interdisciplinary approach [13]. Interdisciplinary integrated learning models can cross each other, making students think more complex and improve students' reasoning abilities [14].

The research results from microtremor data to determine the level of earthquake hazard vulnerability linked to land use in the Village of Bobanehena will be used as a source of information integrated into the material of Vibrations and Waves by using an integrated type learning [15]. It is because the causes, processes, and impacts of an earthquake are very relevant to physics subjects, especially the concepts of Vibrations and Waves.

The integration of microtremor data research results into teaching concepts of Vibration and Wave concepts requires material analysis to make the topic of microtremor data presented in accordance with the teaching material to be learned. It is important to conduct material analysis so that the implementation of learning can achieve the goals [16].

This study aims to determine the effect of an integrated learning model based on microtremor data integrated into the material Vibration and Waves on students' mastery of materials.

## II. METHOD

The research method consists of several stages, namely scientific research and educational research.

### Scientific Research

This research is field research conducted in Bobanehena Village, Jailolo District, West Halmahera Regency. Implementation of the research results on the level of earthquake hazard vulnerability in class XI-A SMK Negeri 1 West Halmahera located in the village of Bobanehena, according to Figure 1.

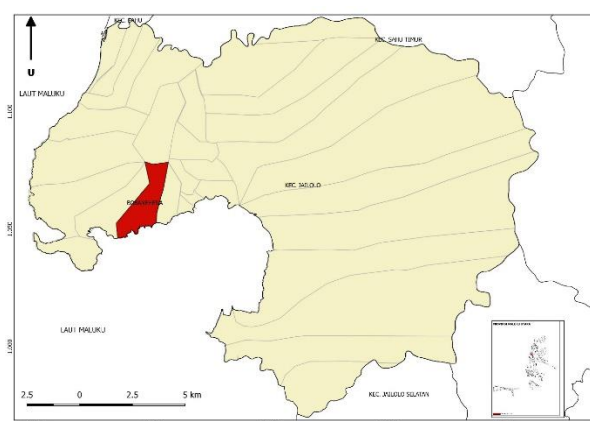


Figure 1. Research Location Map

Data collection on the level of earthquake hazard vulnerability in Bobanehena Village was carried out by taking a microtremor data and using a set of 5-point TDS-303 type Seismometers, Global Position System (GPS), geopsy software, and QGIS, and laptops, according to Figure 2.



Figure 2. Instrumentation Used in Microtremor Data Retrieval

### Educational Research

In collecting the data to determine the level of the students' mastery of materials, the learning outcomes are taken from the assessment score in the form of a test after learning through an integrated type of integrated learning model. To find out students' responses in the integrated learning model, a questionnaire was given. The instrument used will be validated and reliably calculated. To determine the reliability, the essay test taken from the trial test is analyzed by using the alpha formula in Equation [17].

$$r_{11} = \left( \frac{n}{n-1} \right) \left( 1 - \frac{\sum S_i^2}{S_t^2} \right) \quad (1)$$

This research uses the correlation method, and the type of research is experimental research, which involves 22 students of class XI. Samples are taken from cluster sampling techniques. This research's variables consist of the independent variable (an integrated type of integrated learning model) and the dependent variable (mastery of the material).

Stages of an integrated type of integrated learning model are the teacher chooses concepts, knowledge, attitudes, and skills learned from science's multidiscipline. Furthermore, the knowledge of concepts, skills, and attitudes with close and overlapping relationships in multiple disciplines is established [18].

### Science Data Processing

Microtremor data results in the field are then processed using Geopsy and Matlab software to obtain frequency and amplitude values. Then the value of earthquake hazard vulnerability is generated from the frequency, amplitude, and period values. Earthquake hazard vulnerability values are mapped to be analyzed and used as information on learning. Data obtained are analyzed by squaring the microtremor spectrum's peak divided by resonant frequency formulated in Equation 2 [19-22].

$$K_g = A^2/f_0 \tag{2}$$

Where  $K_g$  is the seismic vulnerability index,  $A^2$  is the amplification factor, and  $f_0$  is the resonance frequency.

### Educational Data Processing

Data sources used by researchers are test and questionnaire, but before the test and questionnaires are applied, the instrument eligibility testing must be done by calculating the instrument's reliability, according to Table 1.

**Table 1. The reliability level of the questions [17]**

Alpha	Level of reliability
0.00 – 0.20	Very Low
0.21 – 0.40	Low
0.41 – 0.60	Adequate
0.61 – 0.80	High
0.81 – 1.00	Very High

To find out the distinguishing features of a problem, the formula used is

$$DP = \frac{\text{upper class mean} - \text{lower class mean}}{\text{maximum score}} \tag{3}$$

The distinguishing interpretation of a test is, according to Table 2.

**Table 2. Distinguishing Power Categories [17]**

Interval	Categories
$0.00 \leq D \leq 0.20$	Poor
$0.21 \leq D \leq 0.40$	Adequate
$0.41 \leq D \leq 0.70$	Good
$0.71 \leq D \leq 1.00$	Very Good

The data analysis technique used to determine the students' mastery of materials is to test hypotheses with a t-test. However, before conducting the t-test, the analysis prerequisite tests such as homogeneity, normality, and simple regression tests are carried out.

### III. RESULTS AND DISCUSSION

#### Result and Discussion of Scientific Research

The microtremor data calculation is then mapped to be associated with the earthquake hazard level at the data collection location and indicated by a seismic vulnerability index as according to Table 3.

Table 3 shows that the value of earthquake hazard vulnerability in the Bobanehena Village is 15.8 - 273.3, with the average cost included in the Medium to High category. This is shown in the most severe damage in Bobanehena Village in the earthquake of 2015. Seismic vulnerability index ( $K_g$ ) is an index that describes the level of surface soil susceptibility to deformation during an earthquake [23].

The data obtained is then processed using Geopsy software and then using QGIS software to produce a seismic vulnerability index ( $K_g$ ) map, according to Figure 3.

**Table 3. Microtremor Data Value of Bobanehena Village**

Point	Measurement Coordinates		A	f	T	Kg
	Latitude	Longitude				
B1	1.0538	127.4474	0.38	7.5	2.667	150.0
B2	1.0552	127.4486	3.75	9.8	0.267	25.4
B3	1.0556	127.4458	0.27	8.5	3.751	273.3
B4	1.0531	127.4483	4.90	8.8	0.204	15.8
B5	1.0503	127.4442	0.77	9.8	1.305	125.1

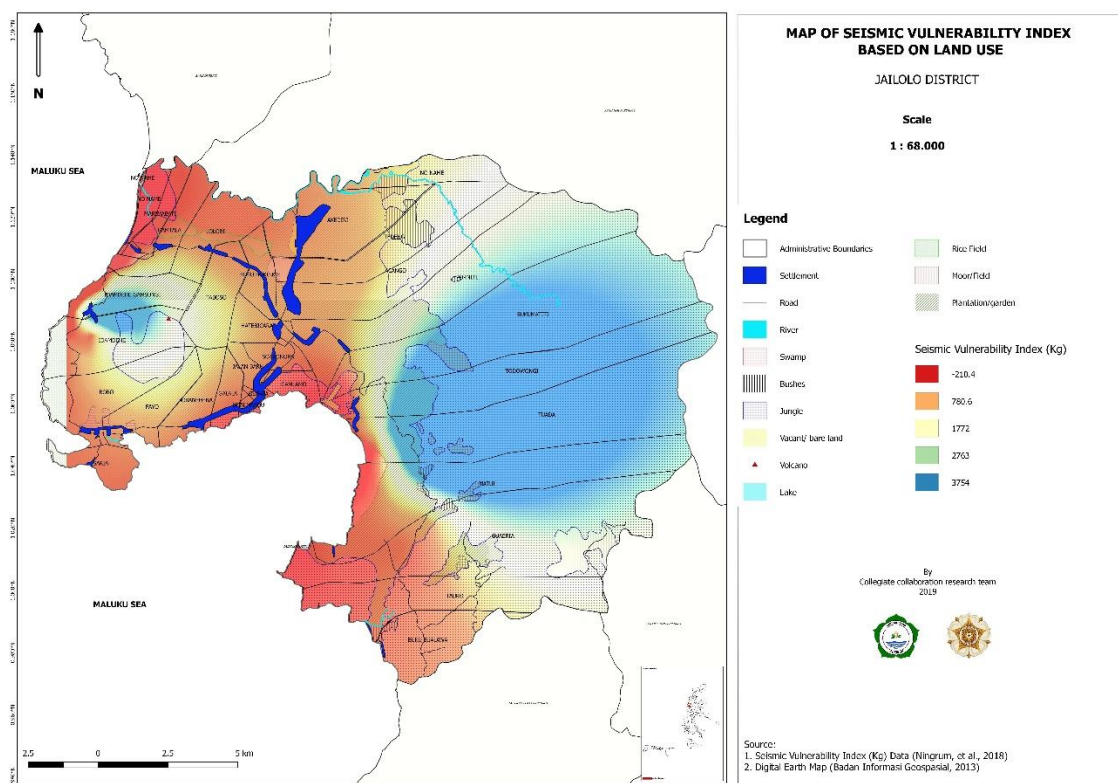


Figure 3. Earthquake Hazard Vulnerability Map of Bobanehena Village

### Result and Discussion of Educational Research

After the mapping results, the level of earthquake hazard vulnerability is obtained, then the data is integrated into vibration and wave material in the form of teaching materials and learning media, then it is taught to students.

Table 4. Frequency Distribution of Student Responses in Integrated Learning Integrated Type

No	Interval Class	Frequency		
		Absolute	Relative	Cumulative
1	44-51	9	40.86	40.86
2	52-59	7	31.78	72.64
3	60-67	1	4.54	77.18
4	68-75	4	18.16	95.34
5	76-83	1	4.54	99.88
Sum $\Sigma$ (f)		22	99.88	

Students' responses to an integrated type of integrated learning model through the questionnaire show score from 44 to 82 with an average score of 38. The students' positive response to the integrated type of integrated learning model is 59%, while the Rohima Wahyu Ningrum, et al

negative response is 57%, according to Table 4.

It indicates that the integrated learning model of the integrated type is quite fun and can improve students' mastery of the material on the concepts of vibration and waves. The results of the analysis of students' responses, according to Figure 4.

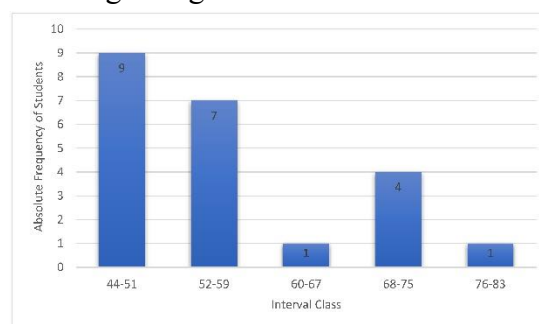


Figure 4. Graphic of Students' Responses to Integrated Learning Models Integrated Type

The implementation of integrated learning model can improve communicative skills (reading, listening, speaking, and writing), cognitive abilities, and students' motivation [24].

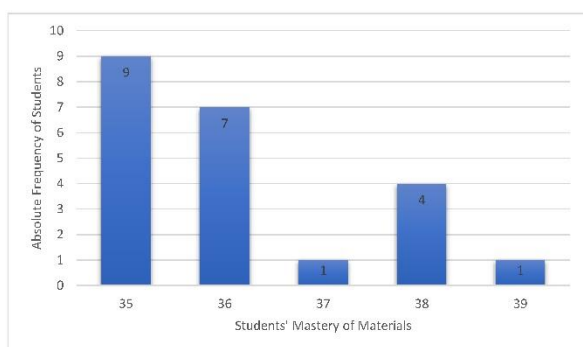


Fun is a subjective feeling that comes from affective or stimulus experiences. So that if the learning process can control students' emotions, it will be easy for teachers to achieve learning goals. This psychological factor act as an internal factor in influencing students' learning [25].

**Table 5. Frequency Distribution of student Material Mastery Data**

No	Interval		Frequency	
	Class	Absolute	Relative	Cumulative
1	35	9	40.91	40.91
2	36	8	36.36	77.27
3	37	3	13.64	90.91
4	38	2	9.09	100
5	39	-	-	
<b>Sum <math>\Sigma</math> (f)</b>		22	100	

Referring to the research data analysis on students' mastery, the lowest score is 35, and the highest score is 38, with an average score of 3.0. The data analysis shows that the average score of 35.91, standard deviations of 1.0, and the variance of 0.94. From these results, a frequency distribution of the students' mastery of variable data according to Table 5 and Figure 5.



**Figure 5. Graphic of Student Materials Mastery**

Furthermore, the requirements analysis and hypothesis testing have been done, which show the effect of the integrated type of integrated learning model on the students' mastery of the material in the concepts of vibration and waves at a significant level of 5%. This result means that there is a positive effect of learning responses and students' mastery of the material. Simultaneously, the *Rohima Wahyu Ningrum, et al*

level of correlation is sufficient, with a score of 0.40, which follows the guidelines for the interpretation of coefficients [26].

Then, to test the correlation's significance, the t-test is used, and the results are  $t_{value} > t_{tab}$  ( $1.95 > 1.725$ ) so that  $H_a$  is accepted and  $H_0$  is rejected. It is concluded that there is a significant effect on students' materials mastery on the vibration and waves by using an integrated type of integrated learning model. Integrating the material with a process to identify attitudes and skills can make students more motivated so that understanding the material as a whole is easier [27].

In learning theory, students must learn from their experiences; integrated learning here emphasizes more on the active involvement of students in the learning process [28]. The concept of education makes the teacher associates the material taught with students' daily lives and encourages students to connect the knowledge they have with their application in life [29]. This concept makes learning more enjoyable, and it encourages the students to be active in learning activities [30].

The effect of the integrated learning model of integrated type on students' materials mastery of vibration and waves is 16%, and it is in a low category. It is caused by several factors, namely the lack of researchers and teachers' discussion that leads to the inability of teachers to master the results of research integrated into the material, the lack of learning resources and media facilities, and unimplemented disaster-based curriculum so that learning techniques and materials regarding disaster is not yet stated in the curriculum.

Integrated-type of integrated learning model is able to provide an educational process that gives students a sense of fun and becomes meaningful learning with independent opportunities [31].

#### IV. CONCLUSION

Based on the study, it can be concluded that using microtremor data combined with an integrated type of integrated learning model on students' mastery of the material in the implementation of physics learning. The amount of the effect of the Integrated-type integrated learning model on the students' mastery of material on the concepts of vibration and waves is 16%, which is classified into a low category.

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