Analyze Instructional Materials for Physics Modul Integrated Natural Disasters and Mitigation

Naila Fauza¹, Dina Syaflita¹, Ernidawati¹, Diah Anugrah Dipuja¹, M. Yogi Ryantama Isjoni¹, Neni Hermita¹ Fanny Rahmatina Rahim²

¹FKIP, Universitas Riau, Jl. HR Subrantas, Pekanbaru 28293, Indonesia
²FMIPA, Universitas Negeri Padang, Jl. Prof Hamka, Padang 25131, Indonesia

nailafauza@lecturer.unri.ac.id

Abstract. Today natural disasters are a global issue. Several countries have made strategies in natural disaster mitigation [1]. Natural disasters of land forest fires, smog, floods, and landslides are common disasters in Riau province. Environment and natural disaster phenomena are closely related to physics. Integrated Physics materials of natural disasters can be applied in secondary schools. The teaching materials in general consist of knowledge, skills, and attitudes that students must learn to achieve a standard competence. The purpose of the research is analyze the physics instructional material of natural disasters to build physics modules integrated with natural disasters and mitigation in secondary schools. The method used ADDIE model ( Analyze, Design, Development, Implementation and Evaluation). This research in analyze. The define (analyze) stage is done through field study and literature study to collect the kinds of material that occur in the concept. The scope of the study analyzed the material physics curriculum 2013 high school integrated natural disasters namely particle dynamics, rotation dynamics and equilibrium rigid body, static fluids, dynamic fluids, heat and displacement. This research was conducted at SMAN 15 Pekanbaru City. The school used a revised 2013 curriculum. This research includes qualitative approach research and descriptive research type. The physics that can be integrated are the rotational dynamics and equilibrium of rigid objects, the weight points of objects, static and dynamic fluids and heat and displacement. The material is integrated into the material of natural disasters that often occur in Riau province, namely landslides, forest fires, smog and floods.

1. Introduction
Today natural disasters are a global issue. Several countries have made strategies in natural disaster mitigation [1]. Natural disasters of land forest fires, smog, floods, and landslides are common disasters in Riau province [2][3][4]. This is illustrated in the map of Riau province one of the provinces that suffered the worst damage due to the flood disaster [5]. In addition to flooding, forest and land fires have occurred since 2015 as a result of air pollution that threatens the health of Riau residents [6]. Air pollution is not only from land fires but from some industrial factories. It also has an impact on water pollution [7].
Many factors need to be considered in planning disaster risk reduction, including building public awareness of environmental care and disaster mitigation [8]. Physics is the science that studies phenomena or natural processes for the development of technology and other sciences [9]. Environment and natural disaster phenomena are closely related to physics. Integrated Physics materials of natural disasters can be applied in secondary schools. The teaching materials in general consist of knowledge, skills, and attitudes that students must learn to achieve a standard competence. Science learning quality needs to be improved to achieve a level of sustainable development [10].

In detail, these types of learning materials consist of knowledge (facts, concepts, principles, procedures) of skills, and attitudes or values [11]. The principles in the selection of learning materials include the principles of relevance, consistency, and adequacy. The three principles are presented as follows: (1) the principle of relevance, meaning interconnectedness. Learning materials should be relevant or have to do with the achievement of standard competencies and basic competencies. With this basic principle, the teacher will know whether the material to be taught is fact material, concepts, principles, procedures, aspects of attitudes or psychomotor aspects so that in turn the teacher avoids the wrong selection of material types that are not relevant to the achievement of standard competencies and basic competencies; (2) Educators are providing a fun learning.

Students have difficulty visualizing natural disasters in the process of natural disasters [12]. Physics Module is one of the integrated teaching materials of natural disasters that can describe natural disasters as well as disaster mitigation. Through the integrated physics module of natural disasters, students can analyze the concept of physics related to natural disasters and mitigation. Modules can be organized based on students' wishes, make room to pour students' ideas, and train students to work on problems and problems independently [13]. During the covid-19 pandemic, students are required to study alone at home. Students have learning difficulties in understanding physics during the pandemic [14]. Modules are the right solution to accommodate students' ideas independently.

The purpose of the research is to analyze the physics instructional material of natural disasters to build physics modules integrated with natural disasters and mitigation in secondary schools. The scope of the study analyzed the material physics curriculum 2013 high school integrated natural disasters namely particle dynamics, rotation dynamics and equilibrium rigid body, static fluids, dynamic fluids, heat and displacement.

2 Methodology

The method used ADDIE model (Analyze, Design, Development, Implementation and Evaluation). This research in analyze analysis is a calculation of needs such as steps to categorize research problem (need) [15]. The define (analyze) stage is done through field study and literature study to collect the kinds of material that occur in the concept [16]. One of part in define is analyze instructional material. This research was conducted at SMAN 15 Pekanbaru City. The school used a revised 2013 curriculum. Based on the revised 2013 curriculum syllabus, indicators developed physics materials are integrated with natural disaster materials and mitigation includes material dynamics of rotation of rigid body, static and dynamic fluids, heat and displacement. Research time semester 1 school year 2020/2021. This research includes qualitative approach research and descriptive research type. Integrated Physics materials of natural disasters and mitigation are described in the form of tables. A material analysis instrument is an analysis sheet in the form of a table. The table contains basic competencies and development of integrated physics material indicators of natural disasters such as floods, landslides, forest fires, smog.

3 Result dan discussion

Material analysis is important to developing physics modules integrated natural disasters and mitigation. Physics materials that are the focus of research are particle dynamics, rotational dynamics and equilibrium of rigid body, static and dynamic fluids as well as heat and displacement. The material is integrated into the material of natural disasters that often occur in Riau province such as landslides,
forest fires, smog and floods. The relationship of Physics material and natural disaster material can be described in the following image

Figure 1. Relationship of Physical with Natural Disaster Materials

Based on Figure 1, some of the materials of high school physics such as particle dynamics, rotational dynamics and balance of rigid body, static fluids, dynamic fluids and heat and displacement are materials that can be integrated in natural disasters landslides, smog, floods and forest fires. The selection of this material is based on the revised 2013 curriculum syllabus by mapping physics material integrated disaster material. The importance of analysis and mapping of material is determine the type of disaster that corresponds to the teaching material, determine the category of disaster topics into facts, concepts, procedures and metacognitives [17]. Material analysis about facts, concepts, principles and procedures is a form of identification of the material to be relevant to the development of teaching materials in learning.[18].

Teaching materials that are by the characteristics of students SMAN 15 Pekanbaru is teaching materials in the form of modules. The advantages of this integrated module of natural disasters contain natural disaster mitigation. Considering Riau is a disaster-prone area, it is necessary to care about the environment and the preparedness or vigilance of natural disasters. Given the increasing number of natural disasters in Indonesia, material awareness of natural disasters needs to be integrated in all subjects at the level of primary, secondary and higher education. Teachers have challenges how to invite teachers of other subjects to learn disaster integration in school environments and other schools. [19]. Natural disaster material can be integrated into learning indicators. Integrated indicators of natural disasters can be seen in Table 1.
| Basic Competencies                                                                 | indicators                                                                                                                                                                                                 |
|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.4 Analyze the relationship between force, mass, and movement of objects on straight motion | Define the definition of force, mention examples of force in daily life, explain the various forms of force in Newton's law concepts and force work on slopes, describe the different force experienced by objects and force that work on slopes, define Newton's first law, second law, and third law, identifying examples of Newton's law in daily life, describe the magnitude associated with Newton's law concept, solving the physics of Newton's law, analyze Newton's law on landslides, solving the physics of Newton's law in landslides, analyze the relationship between force, mass, and movement of objects on straight motion |
| 3.1 Applying the concept of dynamics rotation of rigid body in daily life          | explain the concept of a moment force, determine the relationship between the moment force, arm force, and force that works on an avalanche material, explain the concept of landslide material inertia moment, explain the angular momentum, explaining objects (landslide material that moves marbles) rotate has kinetic energy rotation |
| 3.4 Applying fluid laws in daily life                                             | analyze static fluids, on the main laws of hydrostatic and hydrostatic pressure, their application in daily life especially flood disasters, analyze Pascal's Law and its application in daily life, analyze the Archimedes law and application in daily life, analyze capillaries and surface tension and their application in daily life, explain the ideal fluid requirements, characteristics of dynamic fluids, types of fluid flow, components in dynamic fluids, analyze the concept of Continuity Equation, applying the concept of continuity equations in flood and smog, analyze Bernoulli's law concept, apply Bernoulli's law application in daily life and flood and smog, apply the working principle of the Toricelli theorem to carburetors, venturi meters, pitot tubes, and mosquito sprayers/perfume |
| 3.5 Analyzing the effects of heat and heat transfer that includes thermal characteristics of a material, capacity, and conductivity in daily life | Describe the definition of temperature, compare the measurement scale of thermometer celsius with other thermometer measurement scales, analyze the effect of heat on changes in the temperature of objects, analyzing the effect of changes in the temperature of objects on the size of objects (expansion), analyzing the effect of heat on changes in the form of objects, apply black azas to determine the calorific type of material, analyzing heat transfer by conduction, convection and radiation, applying the concept of heat transfer to smog and land fires, identify factors that can affect conduction, convection and radiation heat |
Based on Table 1 basic competencies are break down into several indicators. The indicator is integrated natural disaster material. Indicators develop into learning objectives. Materials are built on learning objectives. Physics materials are packaged in modules. Modules are packaged attractively, practically and effectively. The learning material basically consists of facts, concepts, principles and procedures. One of the integrated physics materials of natural disasters is particle dynamics. The material is presented in Table 2.

**Table 2. Particle Dynamics material analysis**

|   | Fact | Landslide events can be observed in the environment. It was a mass movement of landslide material. The movement has to do with the force that influences it. |
|---|------|-----------------------------------------------------------------------------------------------------------------------------------|
| 2 | Concept | a. force  
b. kind of force  
c. Relation of force and mass of landslide material  
d. Force works in landslide |
| 3 | Principle | a. Newton first law  
\[ \Sigma F = 0 \]  
Stationary thing \( (v = 0) \) straight motion \( (v \text{ tetap}) \), \( a = 0 \)  
b. Newton second law  
\[ a = \frac{\Sigma F}{m} \]  
c. Newton third law  
\[ F_{\text{aksi}} = -F_{\text{reaksi}} \] |
| 4 | procedure | The steps determine the force components that work on the slope according to Newton's law.  
a. Draw a free diagram.  
b. Specify the style that works on each component.  
c. Calculate the amount requested  
d. Application of Newton's law on landslides |

Based on Table 2, particle dynamics material is built based on observations in the form of facts that occur in the surrounding environment, namely natural disasters landslides. Landslide is the mass movement of landslide material in the form of soil, stone and others. The landslide material moves due to the force that works on the object. This style relates to Newton's Law. Newton's law is a principle. The troubleshooting procedure goes through steps in accordance with the principles. Therefore facts, concepts, principles and procedures related to forming a learning material. Knowledge of facts, concepts and procedures is knowledge that is directly constructed from facts or objects observed [20].

**4. Conclusion**

Based on the results and eradication can be concluded material analysis is very necessary in developing modules. The physics that can be integrated are the rotational dynamics and equilibrium of rigid objects, the weight points of objects, static and dynamic fluids and heat and displacement. The material is integrated into the material of natural disasters that often occur in Riau province, namely landslides, forest fires, smog and floods. Integrated physics analysis of natural disasters includes facts,
concepts, principles, and procedures. The implications in this study are expected that researchers further develop other physics concepts for different disasters so that students’ cognitive develops according to environmental conditions.

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