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# Mapping environmental curriculum in physics learning at senior high school grade X semester 2

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**Abstract.** Global issues about the environment become a trending topic and often heard in today's era. There have been many reports of environmental damage occurring in Indonesia, ranging from floods, forest fires, waste handling problems, air pollution and landslides. So that it takes the care of the young generation for the environment from an early age by providing environmental education in schools. Environmental education given to students will have a positive impact, namely students are able to solve and prevent environmental problems they face. Environmental education will foster students' environmental literacy. Environmental literacy is needed so that students are responsible and care for their environment. Therefore, it is necessary to instill environmental literacy in children from an early age through formal education, by integrating it in the learning process. One of them is by integrating through the subject matter that will be taught to students. The purpose of this research is to map the hidden environmental curriculum in the physics learning materials of senior high school grade X semester 2. This research is a descriptive study with a qualitative approach. This study describes the physics material for grade X semester 2 which contains environmental literacy. The data collection technique used in this research was through documentation study and the data analysis technique used in this study was the content analysis technique. The results of this study are in the form of an integrated environmental literacy matrix which can be used as a reference for physics learning tools.

## 1. Introduction

The development of the industrial revolution has an impact on advances in science and technology. The rapid development of technology is a need that must be met. This development has both positive and negative impacts on humans. Negative impacts will arise if humans cannot control their development properly [1]. One of the negative impacts it causes is a decrease in the quality of the environment every day [2].

Global issues about the environment have become a trending topic and are often heard in today's times. There are many reports of environmental damage that has occurred in Indonesia, ranging from floods, forest fires, waste management problems, air pollution, landslides, drought and tornadoes [3] [4] [5]. Based on the results of the OECD (Organization for Economic Co-operation and Development) the Environmental Outlook to 2030 identifies several environmental problems based on their management, namely climate change, ecosystem quality related to the loss of biodiversity, illegal logging of trees, availability of clean water, and processing of hazardous waste such as materials. chemistry in a product.



This damage is caused by illegal logging [6], excessive use of natural resources, a growing population [7], excessive human activity [8], and the lack of concern for the younger generation of environmental conditions. Overcoming these environmental problems the younger generation must have environmental care behavior [9], by instilling environmental education in children from an early age through formal education and integrating it in the learning process [10]. This integration can develop students' knowledge, skills, technology and knowledge about the environment around them [11]. Environmental education given to students will have a positive impact including students being able to solve and prevent environmental problems they face [12].

The government has made various efforts regarding environmental education, including by integrating environmental education into subjects at all levels of education starting from elementary, junior high, high school and beautiful school programs. This is stated in the Law on Guidance and Development of Environmental Education No. 0142 / U / 1996 and No. Kep. 89 / MENLH / 5/1996. Subsequently, the Minister of Environment and the Minister of National Education issued joint decrees No Kep.07 / MenLH / 06/2005 and No.05 / VI / KB / 2005 which serve as the basis for the guidance and development of environmental education at every level of education. Thus, it is hoped that the policy can improve students' environmental literacy.

Literacy describes a person's ability to identify, understand, interpret, create, communicate and use skills and knowledge in various contexts [10]. Environmental literacy is an ability that a person has to maintain, restore and improve environmental systems through knowledge, skills and awareness of the environment. Students who have environmental literacy will be responsible and care for their environment [13] [14].

Students' environmental literacy can be measured through four components, namely 1) Knowledge of the environment related to the basics of the environment, 2) Attitudes towards the environment including one's view of the environment, sensitivity to environmental conditions and feelings towards the environment, 3) Cognitive skills include identification of environmental problems, environmental analysis and implementation of planning, 4) Behavior which includes real action against the environment [15]. The four components are used as a reference to measure the extent of a person's environmental literacy. Environment Education and Training Partnership (EETAP) emphasizes that someone who has environmental literacy knows what to do for their environment [16].

Even though learning about the environment has been implemented, there are still many students who have low attitudes and care for the environment [17]. This is because environmental education learning is only oriented to cognitive aspects and does not develop values and behaviors that can be used later by students to overcome problems related to the environment [18]. Based on research conducted, the environmental literacy of students in five ASEAN countries, one of which is Indonesia, is in the poor predicate. This is due to several factors, namely: 1) The existing curriculum is only limited to the depth of content and the breadth of the study scope, 2) Teachers who are less trained in environment-based learning, 3) Teachers are more focused on achieving the objectives of the material and provide less special attention to environmental education, 4) Teaching environmental material focuses more on the cognitive aspects, 5) The strategies used in the learning process are more material oriented, 6) Local knowledge and environmental conditions at present are not used as learning resources [19] [20] [21]. As well as learning resources that are used to support the learning process only in the form of text books, worksheets, non-text books, and contextual videos that are not integrated with the environment [22] [23]. Overcoming these problems, it is necessary to develop teaching materials that are used as support in learning.

Teaching material is a generic term that is used as a support by teachers in the learning process to increase success in the teaching and learning process [24]. The teaching materials to be developed are in the form of electronic worksheets. Electronic worksheets are student worksheets that use computer media. Before developing teaching materials, an analysis is needed related to the curriculum, teaching resources and materials, and the material to be taught. One of the material analyzes to be carried out is physics subject matter. Physics is a branch of Natural Science that discusses everything that exists in this universe, and contains facts, concepts, principles and procedures used to explain existing

phenomena [25] [26]. Physics material also contains the concept of environmental literacy because this subject cannot be separated from the context of nature and human life, therefore an analysis of this material is needed. The physics material that will be analyzed is the physics material for senior high school grade X semester 2. The purpose of this study is to map the hidden curriculum environment in the second semester of senior high school physics learning.

## 2. Research Methodology

This research is a descriptive study with a qualitative approach. Descriptive research aims to describe or describe systematically, factually, and accurately about the phenomena or relationships between the phenomena being investigated [27]. This study describes the physics material for grade X semester 2 which contains environmental literacy. The procedure in this study is divided into three stages, namely: the preparation stage, the implementation stage, and the completion stage. The preparation stage for obtaining information about the physics material for grade X semester 2 which contains environmental literacy is conducting a preliminary study, preparing a research design, determining the subject and object of the study. The implementation stage collected data as needed, namely by analyzing the physics material for grade X semester 2 which contained environmental literacy. Finally, the completion stage, there are several things that must be done, namely: processing the research data, drawing conclusions from the research conducted and reporting the results of the research. The data collection techniques used in this study were through documentation study and data analysis techniques used in this study. is a content analysis technique, namely by analyzing the content of written data.

## 3. Result and Discussion

After going through the research steps as presented in the method, the following results were obtained:

### 3.1. Analysis Of Basic Competency (BC)

Based on the analysis that has been carried out on the basic competencies of physics material for senior high school grade X semester 2 and refers to competency standards, learning indicators so that the results of BC analysis can be obtained as follows:

**Table 1.** Analysis of Basic Competencies of Physics Material for grade X semester 2

Basic Competencies	Competency Level	Essential Concepts	Media & Teaching Materials Needed	Application
3.7 Analyze the interaction of forces and the relationship between force, mass and motion of objects in straight motion	Analyze (C4) Operasional Verb (OV) To Measure Achievement:	<ul style="list-style-type: none"> <li>• Moisture</li> <li>• Force</li> <li>• Force resultant</li> <li>• Weight</li> <li>• Friction</li> <li>• Push force</li> <li>• Pull force</li> <li>• Voltage</li> <li>• Style of action</li> <li>• Reaction style</li> <li>• Acceleration</li> <li>• Speed</li> <li>• Displacement</li> </ul>	<ul style="list-style-type: none"> <li>• Newton's law experiment al set</li> <li>• Power point (PPT),</li> <li>• Videos.</li> <li>• Textbook</li> <li>• Student Worksheet</li> <li>• Handouts</li> <li>• Modules</li> </ul>	<ul style="list-style-type: none"> <li>• Use of a seat belt</li> <li>• Cars unloaded from trucks</li> <li>• The mass of people will change while in the elevator</li> <li>• People draw wells using pulleys</li> <li>• Car tires that are braked experience friction</li> </ul>
4.7 Conducting the experiment and the presentation of the results regarding the interaction of force and the relationship of force, mass and acceleration in straight motion and	<ul style="list-style-type: none"> <li>• Identify the application of Newton's I, II and III Laws</li> <li>• Discuss the relationship of F, m, a, motion of objects, factions, reactions, friction forces</li> <li>• Analyze the application of</li> </ul>			

their physical meaning.	Newton's Law in various fields			
3.8 Analyze the order of the planets in their solar system based on Newton's laws	Analyze (C4) OV to measure achievement:	<ul style="list-style-type: none"> <li>• The gravitational force between particles</li> <li>• Gravity</li> <li>• Force result</li> <li>• Strong gravitational field</li> <li>• Acceleration due to gravity</li> <li>• Release speed</li> <li>• Distance between 2 planets</li> <li>• Period relationship with distance</li> <li>• Kepler I Law</li> <li>• Kepler II Law</li> <li>• Kepler III Law</li> </ul>	<ul style="list-style-type: none"> <li>• Artificial satellite data</li> <li>• PPT</li> <li>• Video.</li> <li>• Textbook</li> <li>• Student Worksheet</li> <li>• Handout</li> <li>• Module</li> </ul>	<ul style="list-style-type: none"> <li>• Free falling object to the earth's surface (ground)</li> <li>• The moon does not fall to earth despite its great mass</li> <li>• Artificial satellites do not fall to earth</li> </ul>
4.8 Presenting works regarding the motion of artificial satellites orbiting the earth, their use and the impacts caused by various information sources	<ul style="list-style-type: none"> <li>• Discuss the concepts of gravitational force, gravitational acceleration, and gravitational field strength, and Kepler's law based on Newton's laws of gravity</li> <li>• Calculates the resultant force</li> <li>• Analyze relationships: <ul style="list-style-type: none"> <li>✓ Gravitational force, mass and distance</li> <li>✓ Acceleration due to gravity and field strength</li> <li>✓ T (Period) and R (Distance)</li> </ul> </li> </ul>			
3.9 Analyze the concept of energy, effort (work), business relations (work) and energy changes, the law of conservation of energy, and their application in everyday events	Analyze (C4) OV to measure achievement:	<ul style="list-style-type: none"> <li>• Kinetic energy</li> <li>• Potential energy</li> <li>• Energy</li> <li>• Effort</li> <li>• Straight motion</li> <li>• Circular motion</li> <li>• Parabolic motion</li> <li>• Flat plane</li> <li>• Inclined plane</li> <li>• Vertical motion</li> <li>• Mechanical energy</li> <li>• The law of conservation of mechanical</li> </ul>	<ul style="list-style-type: none"> <li>• Energy conservation law experiment set</li> <li>• PPT</li> <li>• Video</li> <li>• Handout</li> <li>• Module</li> <li>• Textbook</li> <li>• Student Worksheet</li> </ul>	<ul style="list-style-type: none"> <li>• The cyclist pedals on the uphill and horizontal road</li> <li>• People pushing trolleys</li> <li>• Athlete lifting barbell</li> <li>• A motor that is fueled and can run</li> <li>• People light matches</li> <li>• People climb mountains</li> <li>• Athletes do pole jump</li> </ul>
4.9 Proposing the idea of solving problems of motion in everyday life by applying the scientific method, the concept of energy, work, and the law of conservation of	<ul style="list-style-type: none"> <li>• Discuss <math>E_k</math>, <math>E_p</math>, <math>\Delta E_p</math>, <math>\Delta E_k</math>, <math>\Delta E_m</math> and P</li> <li>• Identify the graphs of F and s</li> <li>• Analyze the relationship between W and <math>E_p</math> and <math>E_k</math></li> <li>• Analyzing the form of conservation of mechanical energy in various motion (parabolic motion, motion in</li> </ul>			

energy	a circular plane, and motion of satellites / planets in the solar system)	energy		
3.10 Applying the concepts of momentum and impulse, as well as the law of conservation of momentum in everyday life	Apply (C3) OV to measure achievement	<ul style="list-style-type: none"> <li>• Impulse</li> <li>• Momentum</li> <li>• Motion of objects</li> <li>• Mass</li> <li>• Acceleration</li> <li>• Perfect bouncy collision</li> <li>• Partially resilient collisions</li> <li>• Collisions are not resilient at all</li> <li>• Law of conservation of momentum</li> <li>• The law of conservation of energy</li> <li>• Restitution coefficient</li> </ul>	<ul style="list-style-type: none"> <li>• Impulse momentum experiment set</li> <li>• PPT</li> <li>• Video</li> <li>• Textbook</li> <li>• Student Worksheet</li> <li>• Handout</li> <li>• Module</li> <li>•</li> </ul>	Impulse: impact force, collision between vehicles, poke on a billiard ball, hit on a golf ball, the force exerted by a soccer player when he is about to kick the ball. Momentum: Tankers have enormous momentum because of their enormous mass
4.10 Presenting the results of testing the application of the law of conservation of momentum, for example a ball in free fall to the floor and a simple rocket	<ul style="list-style-type: none"> <li>• Identify the concepts of Impulse (I), Momentum (P) and the Law of Conservation of Momentum</li> <li>• Determine e (restitution coefficient)</li> <li>• Applying the Law of Conservation of Energy and the Law of Conservation of Momentum to collisions</li> </ul>	<ul style="list-style-type: none"> <li>• Harmonic vibration characteristics</li> <li>• Deviation</li> <li>• Spring force</li> <li>• Harmonic vibration speed</li> <li>• Harmonic vibration acceleration</li> <li>• Vibration on the spring</li> <li>• Harmonic vibration energy</li> <li>• The angular velocity</li> <li>• Period</li> <li>• Frequency</li> <li>• Pendulum</li> </ul>	<ul style="list-style-type: none"> <li>• Harmonic vibration experiment set</li> <li>• PPT</li> <li>• Video</li> <li>• Textbook</li> <li>• Student Worksheet</li> <li>• Handout</li> <li>• Module</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Retractable catapult</li> <li>• Spring</li> <li>• Pendulum</li> <li>• Clockwise rotation</li> <li>• Swing in the children's playground</li> </ul>
3.11 Analyzing the relationship between force and vibration in everyday life	Analyze (C4) Example of OV to measure achievement:			
4.11 Experiment with harmonic vibrations on simple swings and / or vibration of springs and their presentation and physical meaning	<ul style="list-style-type: none"> <li>• Analyze the graphs of F and <math>\Delta x</math></li> <li>• Analyze the force, deviation, velocity and acceleration on the spring</li> <li>• Analyze experimental results into graphs, determine graphical equations, and interpret data and graphs to determine the</li> </ul>			

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characteristics of	swing
harmonic	• Restore style
vibrations in	• Phase angle
pendulum swings	• Different
and spring	phases
vibrations	•

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### 3.2. Analysis Of Learners

After analyzing the material, then analyzing the students to identify the characteristics of the students as a whole, such as analysis of interests, attitudes, motivation and learning styles. Some indicators of interest are: a) a feeling of pleasure when students have a feeling of being happy about a particular lesson, there will be no sense of compulsion to learn, b) student involvement in doing or working on an activity, c) student attention is the concentration of students on observation and understanding by putting aside another [28]. Students have an interest in a certain object so they will automatically pay attention to that object. Motivation to learn is an internal and external drive in students. Uno stated several indicators of learning motivation as follows: 1) There is a desire and desire to succeed, 2) There is encouragement and need in learning, 3) There are hopes and aspirations for the future, 4) There are activities that are interesting in learning, 5) There are a conducive learning environment, allowing a student to learn well [29].

Attitudes can also be measured using five indicators, including: a) curiosity, b) perseverance, c) creative attitudes and inventions, d) cooperation with others (attitudes to work with people others), as well as e) sensitivity to environment (sensitive attitude towards the environment). In addition, the classification of cognitive learning styles according to James W. Keefe is based on the dimensions of cognitive learning styles. Dimensions of cognitive style in receiving information include; a) Perceptual modality preference, which is a cognitive style related to a person's habits and preferences in using their sense organs. Especially the ability to see movement visually or partially, auditory or verbal understanding; b) Field dependent, namely cognitive style that reflects the way a person analyzes interacting with the environment; c) Scanning, which describes a person's tendency to focus his attention on an information; d) Strong and weakness automatization, which is a description of a person's capacity to perform tasks repeatedly.

### 3.3. Analysis Of Environmental Literacy

Environmental literacy is an important part of developing literacy skills [30]. Environmental literacy is a major part of 21st century education [31]. Measurement of environmental literacy skills is needed to determine the extent of a person's environmental literacy skills, the goal is that follow-up can be done to improve this ability in a person. Environmental literacy consists of four components, namely environmental knowledge which includes environmental basics; attitudes towards the environment which include views of the environment, sensitivity to environmental conditions, and feelings towards the environment; cognitive skills which include identification of environmental problems, environmental analysis and implementation of planning; as well as behavior that includes real action against the environment [32]. A person's environmental literacy skills are needed to take concrete action on the environment in order to maintain its condition and sustainability. Environmental literacy is very suitable if it is integrated in the 2013 Curriculum which focuses on character and competence. Some physics materials contain environmental literacy. The following are the results of the analysis of physics material containing environmental literacy:

**Table 2.** Analysis of Physics Material for grade X semester 2 contains environmental literacy

Basic competencies	Environmental Literacy			
	Environmental Knowledge	Attitude to the environment	Environmental Behavior	Environmental problem solving skills
3.7 Analyze the interaction of forces and the relationship between force, mass and motion of objects in straight motion	<ul style="list-style-type: none"> <li>• Set a safe distance when driving</li> <li>• Take into account enough time to brake the vehicle</li> </ul>	<ul style="list-style-type: none"> <li>• Use and invite other people to wear seat belts when riding in a car.</li> <li>• Use and invite other people to use a helmet when riding a motorbike.</li> <li>• Obey traffic rules.</li> <li>• No speeding on the road.</li> <li>• Maintain a safe distance when driving.</li> <li>• Do not brake suddenly.</li> </ul>	<ul style="list-style-type: none"> <li>• Wear the seat belt properly when riding in a car.</li> <li>• Wear the helmet properly</li> <li>• Maintain a safe distance.</li> <li>• Drive orderly</li> </ul>	<ul style="list-style-type: none"> <li>• Drive in an orderly manner.</li> <li>• Stop right at a traffic light</li> <li>• Reducing the speed before the corner</li> <li>• Do not take other people's paths.</li> <li>• Slow down the vehicle when passing the intersection</li> <li>• Using ropes and pulleys according to the load to be lifted.</li> </ul>
4.7 Conducting the experiment and the presentation of the results regarding the interaction of force and the relationship of force, mass and acceleration in straight motion and their physical meaning.	<ul style="list-style-type: none"> <li>• Understand the seat belt function</li> <li>• Understand the function of a helmet.</li> <li>• Take into account the distance and speed that's safe to overtake</li> </ul>	<ul style="list-style-type: none"> <li>• Understand that the sun plays an important role in the solar system and life</li> <li>• Understanding the moon lights up at night</li> </ul>	<ul style="list-style-type: none"> <li>• Explaining the use of the sun as the center of the solar system to others</li> </ul>	<ul style="list-style-type: none"> <li>• Using binoculars to view the solar system</li> </ul>
3.8 Analyze the order of the planets in their solar system based on Newton's laws	<ul style="list-style-type: none"> <li>• The sun is the center of the solar system</li> <li>• The occurrence of events day and night</li> <li>• The moon does not fall to earth despite its great mass</li> <li>• The forces of attraction between the planets make the planets move in their orbits</li> </ul>	<ul style="list-style-type: none"> <li>• Understanding that the sun plays an important role in the solar system and life</li> <li>• Understanding the moon lights up at night</li> </ul>	<ul style="list-style-type: none"> <li>• Explaining the use of the sun as the center of the solar system to others</li> </ul>	<ul style="list-style-type: none"> <li>• Using binoculars to view the solar system</li> </ul>
4.8 Presenting works regarding the motion of artificial satellites orbiting the earth, their use and the impacts caused by various information sources	<ul style="list-style-type: none"> <li>• The sun is the center of the solar system</li> <li>• The occurrence of events day and night</li> <li>• The moon does not fall to earth despite its great mass</li> <li>• The forces of attraction between the planets make the planets move in their orbits</li> </ul>	<ul style="list-style-type: none"> <li>• Understanding that the sun plays an important role in the solar system and life</li> <li>• Understanding the moon lights up at night</li> </ul>	<ul style="list-style-type: none"> <li>• Explaining the use of the sun as the center of the solar system to others</li> </ul>	<ul style="list-style-type: none"> <li>• Using binoculars to view the solar system</li> </ul>
3.9 Analyze the concept of energy, effort (work), business	<ul style="list-style-type: none"> <li>• Knowing that a good effort on the</li> </ul>	<ul style="list-style-type: none"> <li>• Inviting others to keep trying to have a</li> </ul>	<ul style="list-style-type: none"> <li>• Always be sensitive to the</li> </ul>	<ul style="list-style-type: none"> <li>• Doing a big effort will produce good</li> </ul>



relations (work) and energy changes, the law of conservation of energy, and their application in everyday events	environment will have a positive impact on life on earth	positive impact on life on earth	surrounding environment and know the benefits of energy, business that has an impact on the environment	energy for the environment
4.9 Proposing the idea of solving problems of motion in everyday life by applying the scientific method, the concept of energy, work, and the law of conservation of energy	<ul style="list-style-type: none"> <li>Knowing that a motor that is refueled and can run but using excessive fuel can damage the environment</li> </ul>			<ul style="list-style-type: none"> <li>Use fuel as needed to avoid environmental damage</li> </ul>
3.10 Applying the concepts of momentum and impulse, as well as the law of conservation of momentum in everyday life	<ul style="list-style-type: none"> <li>Motorcyclists are required to use an SNI helmet to reduce the very impact when an accident occurs.</li> <li>Wearing gloves by boxers when hitting an opponent</li> </ul>	<ul style="list-style-type: none"> <li>Using and inviting other people to use SNI helmets to reduce the very impact when an accident occurs</li> </ul>	<ul style="list-style-type: none"> <li>Wear the SNI helmet properly until it locks properly to reduce the very impact when an accident occurs</li> </ul>	<ul style="list-style-type: none"> <li>Don't play boxing without gloves</li> <li>Always wear a helmet when riding a motorcycle</li> <li>Take care to carry vehicles to reduce collisions when an accident occurs</li> </ul>
4.10 Presenting the results of testing the application of the law of conservation of momentum, for example a ball in free fall to the floor and a simple rocket				
3.11 Analyzing the relationship between force and vibration in everyday life	<ul style="list-style-type: none"> <li>Know how to play slingshots and swing carefully</li> </ul>	<ul style="list-style-type: none"> <li>Invite people to be careful playing slingshots and swings</li> </ul>	<ul style="list-style-type: none"> <li>Pull the catapult properly so that it is right on target</li> </ul>	<ul style="list-style-type: none"> <li>Play catapult with care</li> <li>Hold on while playing the swing</li> </ul>
4.11 Experiment with harmonic vibrations on simple swings and / or vibration of springs and their presentation and physical meaning	<ul style="list-style-type: none"> <li>Understand stretch the rubber too hard so that it breaks quickly</li> </ul>		<ul style="list-style-type: none"> <li>Do not stretch the rubber too much so it will break quickly</li> </ul>	

Based on table 2, the analysis of physics material for grade X semester 2 shows that each BC contains the concept of environmental literacy. This concept can be used as a guide for teaching environmental concepts to students in school. Environmental education needs to be instilled in the goal of no more damage to the environment due to human actions.

#### 4. Conclusion

Based on the results and discussion that has been done, this mapping is very important to do to find out the media, learning resources and applications of the material being taught as well as to know the physics material for grade X which contains environmental literacy. The result is an integration matrix. This matrix becomes a reference for developing programs and learning tools for the implementation of integration of environmental education in physics learning for senior high school grade X semester 2.

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