

Disaster Readiness and Risk Reduction

Quarter 1 – Module 11: Earthquake Hazards and Risk Reduction Methods



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**Disaster Readiness and Risk Reduction
Alternative Delivery Mode
Quarter 1 – Module 11: Earthquake Hazards and Risk Reduction Methods
First Edition, 2020**

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Secretary: Leonor Magtolis Briones
Undersecretary: Diosdado M. San Antonio

Development Team of the Module

Writers: Rodgem A. Barairo
Ruby C. Bautista

Editors: Aries B. Manalo
Riza Mae S. Sanchez
Josefinia M. Fabra

Reviewers: Desiree D. Vista
Rex J. Vibal

Illustrator: Leumel M. Cadapan

Layout Artists: Dyesa Jane P. Calderon
Leumel M. Cadapan

Management Team: Regional Director: Wilfredo E. Cabral
CLMD Chief: Job S. Zape Jr.
Regional EPS In Charge of LRMS: Eugenio S. Adrao
Regional ADM Coordinator: Elaine T. Balaogan
Regional Librarian: Fe M. Ong-ongwan
School Division Superintendent/s: Rosemarie D. Torres
Assistant School Division Superintendent/s: Ernesto D. Lindo
CID Chief/s: Dolorosa S. De Castro
Division EPS/s In Charge of LRMS: Cristeta M. Arasco

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Department of Education – Region IV-A CALABARZON

Office Address: Gate 2 Karangalan Village, Barangay San Isidro
Cainta, Rizal 1800
Telefax: 02-8682-5773/8684-4914/8647-7487
E-mail Address: region4a@deped.gov.ph / ict.calabarzon@deped.gov.ph

Senior High School

Disaster Readiness and Risk Reduction

Quarter 1 – Module 11: Earthquake Hazards and Risk Reduction Methods

Introductory Message

For the facilitator:

Welcome to the Disaster Readiness and Risk Reduction 11 Alternative Delivery Mode (ADM) Module on Earthquake Hazards and Risk Reduction Methods!

This module was collaboratively designed, developed and reviewed by educators both from public and private institutions to assist you, the teacher or facilitator, in helping the learners meet the standards set by the K to 12 Curriculum while overcoming their personal, social, and economic constraints in schooling.

This learning resource hopes to engage the learners into guided and independent learning activities at their own pace and time. Furthermore, this also aims to help learners acquire the needed 21st century skills while taking into consideration their needs and circumstances.

In addition to the material in the main text, you will also see this box in the body of the module:



Notes to the Teacher

This contains helpful tips or strategies that will help you in guiding the learners.

As a facilitator you are expected to orient the learners on how to use this module. You also need to keep track of the learners' progress while allowing them to manage their own learning. Furthermore, you are expected to encourage and assist the learners as they do the tasks included in the module.

For the learner:

Welcome to the Disaster Readiness and Risk Reduction 11 Alternative Delivery Mode (ADM) Module on Earthquake Hazards and Risk Reduction Methods!

The hand is one of the most symbolized parts of the human body. It is often used to depict skill, action and purpose. Through our hands we may learn, create and accomplish. Hence, the hand in this learning resource signifies that you as a learner is capable and empowered to successfully achieve the relevant competencies and skills at your own pace and time. Your academic success lies in your own hands!

This module was designed to provide you with fun and meaningful opportunities for guided and independent learning at your own pace and time. You will be enabled to process the contents of the learning resource while being an active learner.

This module has the following parts and corresponding icons:



What I Need to Know

This will give you an idea of the skills or competencies you are expected to learn in the module.



What I Know

This part includes an activity that aims to check what you already know about the lesson to take. If you get all the answers correct (100%), you may decide to skip this module.



What's In

This is a brief drill or review to help you link the current lesson with the previous one.



What's New

In this portion, the new lesson will be introduced to you in various ways such as a story, a song, a poem, a problem opener, an activity or a situation.



What is It

This section provides a brief discussion of the lesson. This aims to help you discover and understand new concepts and skills.



What's More

This comprises activities for independent practice to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.



What I Have Learned

This includes questions or blank sentence/paragraph to be filled in to process what you learned from the lesson.



What I Can Do

This section provides an activity which will help you transfer your new knowledge or skill into real life situations or concerns.



Assessment

This is a task which aims to evaluate your level of mastery in achieving the learning competency.



Additional Activities

In this portion, another activity will be given to you to enrich your knowledge or skill of the lesson learned. This also tends retention of learned concepts.



Answer Key

This contains answers to all activities in the module.

At the end of this module you will also find:

References

This is a list of all sources used in developing this module.

The following are some reminders in using this module:

1. Use the module with care. Do not put unnecessary mark/s on any part of the module. Use a separate sheet of paper in answering the exercises.
2. Don't forget to answer *What I Know* before moving on to the other activities included in the module.
3. Read the instruction carefully before doing each task.
4. Observe honesty and integrity in doing the tasks and checking your answers.
5. Finish the task at hand before proceeding to the next.
6. Return this module to your teacher/facilitator once you are through with it.

If you encounter any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator. Always bear in mind that you are not alone.

We hope that through this material, you will experience meaningful learning and gain deep understanding of the relevant competencies. You can do it!



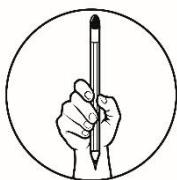
What I Need to Know

If earthquake is regarded as one of the most frightening natural disasters, that is because seconds of its occurrence can be more destructive than days of a typhoon. Besides, an earthquake comes with very little warning.

This module is intended to equip you with knowledge on various potential earthquake hazards and reduction of its risks.

After going through this module, you are expected to:

1. identify various potential earthquake hazards and ways to minimize it;
 2. appreciate the value of preparedness and resilience in disastrous situations; and
 3. create a comic strip about being prepared and resilient.



What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

- What do you call to the ground surface that sinks or settles due to an earthquake?
 - ground shaking
 - liquefaction
 - rupture
 - submerging
 - Which of the following is not a secondary effect of an earthquake?
 - fire
 - landslide
 - surface rupture
 - tsunami
 - Along what type of plate boundaries do earthquakes occur?
 - convergent plate boundaries
 - divergent plate boundaries
 - submergent plate
 - transform-fault boundaries
 - It refers to large ocean waves caused by violent movement in the ocean floor.
 - landslide
 - subsidence

- A. earthquake instrumentation
 - B. hazard mapping
 - C. structural engineering
 - D. None of the above
15. Which of the following is not a secondary hazard caused by an earthquake?
- A. landslides
 - B. liquefaction
 - C. loss of lives
 - D. tsunami

**Lesson
1**

Earthquake Hazards

An earthquake poses a lot of hazards which can contribute to large economic and human losses, and represents a serious impediment to socioeconomic development, creation of jobs and availability of funds for poverty reduction initiatives.

In this module you will be introduced to the different hazards brought about by an earthquake. Earthquake hazard and risk assessment is a fundamental tool for developing risk reduction measures and constitutes the first step to support decisions and actions to reduce potential losses.

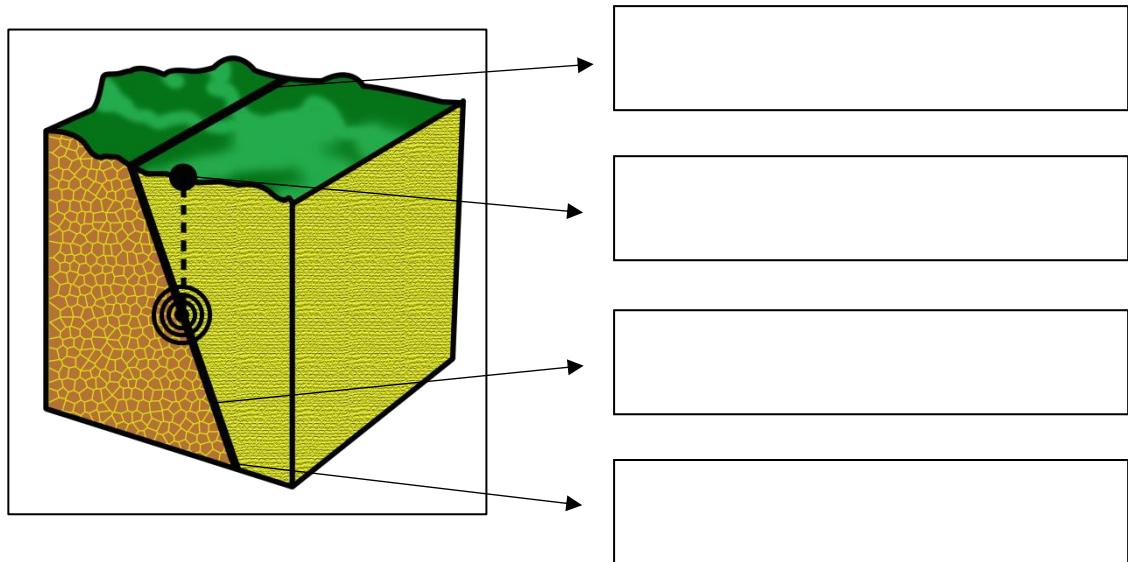


What's In

In your previous lessons about earthquake, you have learned how an earthquake starts, where it usually originates and the type of plate motion that usually causes an earthquake. Now, it is essential for you to learn what are the impending threats and hazards that go along with an occurrence of an earthquake. Ultimately, this will help you develop sense of preparedness by equipping you with necessary knowledge on the different earthquake hazards.

Before you engage with the main objectives of this module, let us have a brief throwback on important concepts about earthquake.

Can you label the picture below? Inside the boxes at the right, write the correct label and give the definition of the term/s.



Now, check your answer in the Answer Key section. Did you get them right?

Let us refresh the following earthquake concepts:

- An earthquake is the vibration of Earth produced by the rapid release of energy within the lithosphere.
- Earthquakes are caused by slippage along a break in the lithosphere, called a fault.
- The energy released by an earthquake travels in all directions from the focus in the form of seismic waves.
- The movement that occurs along faults during earthquakes is a major factor in changing Earth's surface.
- Forces inside Earth slowly deform the rock that makes up Earth's crust, causing rock to bend.
- Elastic rebound is the tendency for the deformed rock along a fault to spring back after an earthquake.
- An aftershock is an earthquake that occurs sometime soon after a major earthquake.
- A seismograph is a device used to record the motion of the ground during an earthquake.

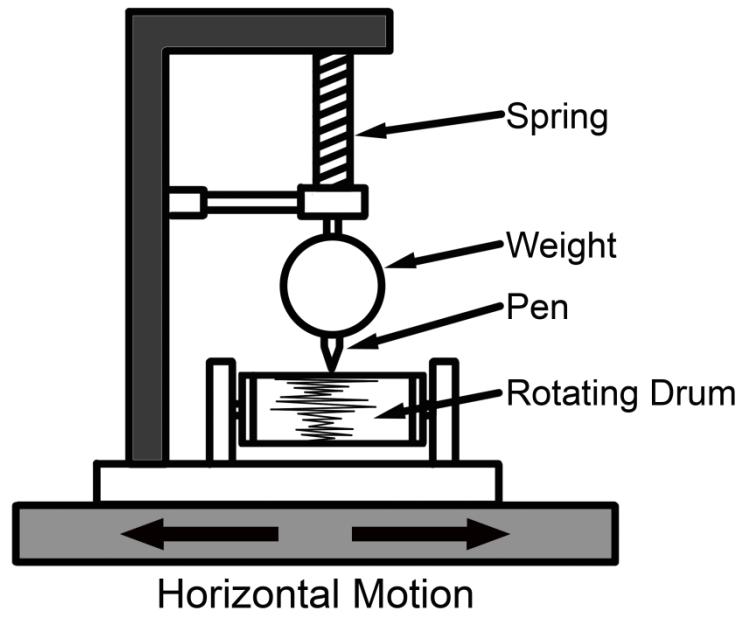


Figure 1. Seismograph



Notes to the Teacher

Aside from the review concepts in *What's In* section of this module, it is a prerequisite for the learner to have understood previous concepts on hazards and mitigation of disaster risks prior to use of this module.



What's New

Who would not know the story of Popoy and Basha? In the movie *One More Chance*, Popoy, who played the role of an architect, was able to fulfill his stubborn vision of building calamity and earthquake-proof housing projects.



Source:, Unreel Ph, "One More Chance and that one scene that broke it", February 16, 2020. 1024 x 576, Accessed July 10, 2020, <https://unreel.ph/feature/one-more-chance-confrontation-scene/>]

Figure 2. Popoy playing the role of an architect wanting to build earthquake-resistant structures

Answer the following questions.

1. What do you think is the reason why Popoy thought of building earthquake-proof houses?

2. What are the possible hazards or dangers that can be caused by an earthquake?

-
3. Based from your previous learnings, what are the materials and structural features of an earthquake-proof house?
-
-



What is It

What are Earthquake Hazards?

Earthquake Hazards refer to earthquake agents which have the potential to cause harm to a vulnerable targets which can either be humans, animals or even your environment.

The effects of an earthquake can be classified as primary or secondary.

- *Primary effects* are permanent features an earthquake can bring out. Examples include fault scarps, surface ruptures, and offsets of natural or human-constructed objects.
- *Secondary effects* happen when ground movement results to other types of destruction. Examples include landslides, tsunami, liquefaction and fire.

Below are the four earthquake hazards which are considered as secondary effects of an earthquake:

1. Landslides

Seismic vibration is a common triggering mechanism for landslides. Landslides can have particularly devastating effects like floods, blocking of rivers, death, and damage to land and natural resources. Landslides can be prevented by reinforcing slope material, modifying the pathway for surface and underwater and by putting piles and retaining walls.



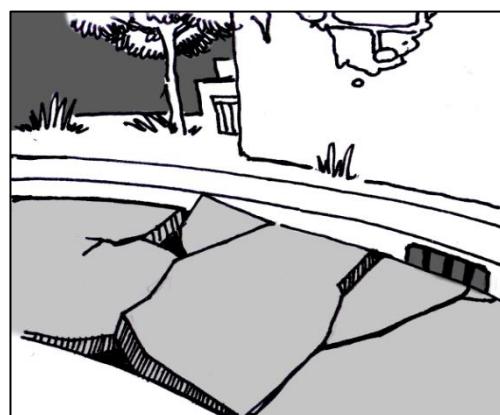
2. Tsunami

A tsunami is a huge sea wave triggered by a violent displacement of the ocean floor. Underwater earthquakes, volcanic eruptions or landslides can cause tsunami. As it approaches a shallow coastline, its speed decreased, but the height of the tsunami increases drastically, bringing so much damage to nearby communities. Tsunamis can also overwhelm sewage systems, destroy structures and kill people.



3. Liquefaction

Earthquake motion can turn loosely packed, water-saturated soil to liquid—"liquefaction." Liquefied soil becomes less compact and ultimately lose the ability to support roads, buried pipes, and, of course, houses. It is caused by vibration or saturation with water which causes the soil to decrease in density. This poses danger for it lead to unstable structures of buildings due to ground subsidence.



4. Fires

Earthquakes cause fires. Even moderate ground shaking can break gas and electrical lines, sever fuel lines, and overturn stoves. To further complicate things, water pipes rupture, so it would be impossible to extinguish the fire.



Most commonly used methods of reducing earthquake risks are as follows:

1. Effective recording and interpretation of ground motion

This can be done by effective instrumentation in order to determine the location, strength and frequency of earthquakes. This assists in providing alerts and warnings especially to high-risk or vulnerable areas for preparation and emergency response.

2. Constructing seismic hazard maps

A seismic hazard map shows the potential hazards in a given area. In many regions in our country, seismic expectancy maps or hazard maps are now available for planning purposes. It serves as basis for disaster management information like locations for evacuation and evacuation

routes. The anticipated intensity of ground shaking is represented by a number called the peak acceleration or the peak velocity.

3. Developing resistant structures

Resistant structures are able to withstand collapse by redistributing forces caused by seismic waves through shear walls. Developing engineered structural designs that are able to resist the forces generated by seismic waves can be achieved either by following building codes based on hazard maps or by appropriate methods of analysis.



Source: Steel for earthquake-proof houses, *Steel-Frames*, 1600 x 680, Published Nov 6, 2017 by Posco Newsroom, Accessed June 2, 2020, <https://dh4drhh3phab.cloudfront.net/en/wp-content/uploads/2017/11/Steel-Frames.jpg>

The Philippines is prone to natural calamities. For this reason, pushing for programs that build calamity-proof housing projects must be given importance. Steel, capable of withstanding enormous force without getting damaged, is usually used as frame in making such houses for it provides great deal of security. Other essential characteristics of steel are easy to maintain and can withstand the test of time and has high strength to weight ratio. Moreover, it is proven to be eco-friendly.

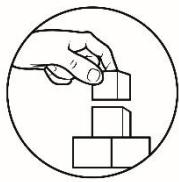
Table 1. Program options that can be taken by government and private institutions to reduce the risks of earthquake hazards

Option	Benefit/ cost range	Benefit
Earthquake scenarios	I-10	Facilitates planning for the expected and the unexpected
Building codes	1-1,000	Prevents collapse of buildings; protects life, reduces injuries
Standards and guidelines	1-1,000	Protects community infrastructure
Siting criteria for land use	1-10	Avoids surface fault rupture, soil failure, and soil-structure resonance
Relocation and rerouting	1-10	Reduces likelihood for damage to important facilities
Demolition	1-1,000	Eliminates collapse hazards and potential for loss of life
Retrofit, strengthening upgrading, and repair	1-100	Prevents collapse, eliminates vulnerabilities, and reduces damage
Performance-based design	1-100	Prevents loss of function and use
Base isolation	1-100	Ensures continued functioning of essential and critical structures
Soil remediation	1-100	Prevents liquefaction, landslides, and lateral spreading
Protective works	I-10	Prevents release of hazardous materials
Change in use	I-10	Reduces likelihood of loss of function
Change in building density	I-10	Lowers the risk to people
Insurance	1-1,000,000	Spreads the risk and enhances recovery; hope for fostering mitigation in the future
Public-private partnerships	1-10	Spreads the responsibility
Training	1-10	Expands the capability of professionals
Non-structural mitigation	1-100,000	Protects equipment and contents; ensures use

Source: adpc. (2001).
Earthquake Vulnerability Reduction for Cities (EVRC-2). Notes

Source: Hays et al., 1998.

The options and benefits of vulnerability reduction mentioned above are based on experiences in developed countries. A refinement of approaches is necessary for selecting and implementing these options in developing countries.



What's More

Activity 1.1: Hurdling Language Barriers to Understand Science

Learning the Skill: Defining terms using context clues

Give the meaning of the underlined words by examining how it is used in the sentence. Look for context clues.

- When the soil is water-saturated, it tends to behave like a liquid. Such behavior leads to secondary earthquake effect which is called liquefaction.

- During earthquakes, LPG tanks and stoves may overturn and electrical lines may sever, and consequently may lead to fire.

- Seismic activities must be monitored because earthquakes originate below the earth's crust.

- Ground subsidence happens because of the soft and liquid-like behavior of some soil.

- A tsunami is caused by earthquake in oceanic floors. This leads to huge flooding in communities near the seashore.

Activity 1.2. Whatta Breakthrough!

Impact-proof desk developed for pre-school students

Published April 28, 2019, 4:02 PM

A group of researchers from the Philippine Normal University (PNU), De La Salle University, and Technological University of the Philippines developed a high impact-proof automated study desk for preschool children following recent consecutive earthquakes in Luzon and Visayas.



Life-Saving Automated Mesa to Endure Seismic Activity or the LAMESA (PHOTO COURTESY OF DOST / MANILA BULLETIN)

Called “LAMESA” for Life-Saving Automated Mesa to Endure Seismic Activity, the desk serves as a “survival tool and a teaching aid to initiate ‘active’ disaster preparation,” according to PNU’s Dr. Marie Paz Morales, research team leader. This was done to help educational institutions become more prepared for quake-related disasters such as “The Big One”.

“The Big One”, a cataclysmic event that the Department of Science and Technology-Philippine Institute of Volcanology and Seismology (DOST-PHIVOLCS) has been forewarning for years, is expected to reach up to magnitude 8.5. Such massive force can substantially destroy populated areas in Metro Manila, including residential areas, businesses, and schools.

“La mesa” or “mesa” means “table” in Filipino.

The desk—measuring 1.22 m in length, 0.69 m in width and 3.327 cm in tabletop thickness—uses lightweight but highly strong and elastic materials to comply with kindergarten standards. Its height of 0.57 m ensures that up to four kindergarteners, with an average height of .91 m (or three feet), will be able to hide under the table.

The steel table top is coated with epoxy paint to make it durable and slick, while the steel legs come with rubber footings to minimize sliding during tremors. Its center legs, meanwhile, support a storage

bin with sliding door for lighting devices plus ample food and water supplies for up to nine kindergarteners.

Moreover, LAMESA is equipped with an accelerometer, a device that senses motion, which feeds seismic measurements to a Wi-Fi-enabled microcontroller. This microcontroller then simultaneously triggers the actuator which causes the table top to fold 16 degrees upward.

LAMESA likewise has a built-in alarm system that activates when vibration levels are above-normal. Further, it has a 13-bit liquid crystal display which shows the intensity level and instructs people to evacuate when needed.

LAMESA combines technology with capacity building in terms of knowledge and infrastructure to best address such probable disaster, particularly in educational institutions.

According to the research team, they developed not only a resilient study desk for kindergartens but also a warning system when earthquakes occur, a safety infrastructure for students to use, and a learning tool to passive disaster preparation of kindergarten.

Source: Dhel Nazario, *Impact-proof desk developed for pre-school students*, Manilla Bulletin, April 28, 2019.

Guide Questions

1. What does LAMESA stand for?
2. What type of materials in making this impact-proof desk?
3. What are the features of the desk?
4. At an expected magnitude of 8.5, how will you describe the strength and damage does the Big One can bring?
5. How important is this invention for young children in school?
6. Why do you think these scientists came up with these inventions?
7. How important is it to be prepared and be resilient?

Activity 1.3. Info-comics

Create a 12-box comic strip which encourages people to appreciate the value of knowing earthquake hazards and risk reduction. You are certainly allowed to go beyond 10 boxes if you want. The rubric below will serve as your guide and your teacher's basis for rating your output.

Table 2. Rubric for comic strip making

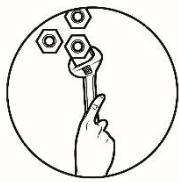
	4	3	2	1
Action	Actions make sense from one panel to another	Most actions make sense from one panel to another	Some actions make sense from one panel to another	Actions never make sense from one panel to another
Landscape and props	Relate to the action and characters in all panels	Relate to the action and characters in most panels	Relate to the action and characters in some panels	Never relate to the action and characters in all panels
Textboxes and bubbles	Well-written, edited for punctuations, grammar and usage in all panels	Well-written, edited for punctuations, grammar and usage in most panels	Well-written, edited for punctuations, grammar and usage in some panels	Not well-written, not edited for punctuations, grammar and usage in all panels
Excitement and interest	Very interesting	interesting	Somewhat interesting	Not interesting at all



What I Have Learned

Fill in the blanks with word/s that will complete the concepts you have learned in this module.

1. Earthquake refers to the sudden _____ of the ground.
2. Earthquake Hazards can cause either _____ or _____ effects.
3. Primary effects are permanent features produced by the earthquake such as _____, _____, and _____.
4. _____ effects result when ground movement causes other types of damage landslides, tsunami, liquefaction and fire.
5. There are ways to reduce the risks of an earthquake. These are _____, _____, and _____.



What I Can Do

Filipinos have been through a lot of disasters- typhoon Yolanda, fire, July 1990-earthquakes, landslides, covid-19 pandemic. Name it and the Filipinos had been through it! Read the poem below, and then answer the questions that follow.

We Filipinos Are Disaster-Resilient, Aren't We?

By Rodgem A. Barairo

*To reduce disaster, is an impossibility
Never ever say,*

*We can prepare
We can think of ways
Because truth is
We're hopeless, down on bended knees*

*Never believe
The government and Filipinos are capable
Because reality is
We can't work hand in hand*

*Never believe
Our nation can be great again
Because truth is
Filipinos are not resilient*

*Forget the thought
That we can't make it
Never ever say
There's hope after a disaster!*

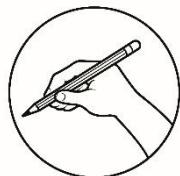
This time, read the poem in reverse, that is, from bottom to top.

Questions

1. Do you think you are a resilient person? Why do you say so?

2. Which manner of reading the poem gives a more realistic characterization of our nation's ability to respond to disasters, from-top-to-bottom, or reverse manner? Justify your answer.

3. As a senior high school student, how can you make yourself disaster-strong and resilient?



Assessment

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which community will be least affected by an earthquake?
 - A community that is within 1km radius of the epicenter.
 - A community that experiences an earthquake with a depth of focus of 100km.
 - A densely populated community that has no earthquake preparedness measures in place.
 - A community that experiences an earthquake with a magnitude of 7.5.
2. Which of the following is caused by a landslide or explosion under the oceans?

A. fire	C. liquefaction
B. ground rupture	D. tsunami

3. At convergent plate boundaries, _____
- Two plates slip past horizontally each other
 - Two plates move in opposite directions away from each other
 - Two plates move in opposite directions toward each other
 - Two plates are moving vertically
4. Which of the following is NOT TRUE about reduction of earthquake risks?
- Hazards maps must be made.
 - Accurate data recording of earthquakes.
 - Strong and resilient buildings must be developed.
 - Careful analysis and interpretation of ground shaking is unnecessary.
5. Which secondary effect of an earthquake is described as collapse of buildings caused by earthquake vibrating water-saturated fill or unconsolidated soil?
- | | |
|--------------|-----------------|
| A. flood | C. liquefaction |
| B. landslide | D. tsunami |
6. Many divergent plate boundaries coincide with _____.
- | | |
|----------------------------|---------------------|
| A. edges of the continents | C. transform faults |
| B. mid-ocean ridge | D. volcano |
7. What might happen when ground shaking results to breakage of gas, electrical lines and fuel lines, and overturning of stoves?
- | | |
|--------------|-----------------|
| A. fire | C. liquefaction |
| B. landslide | D. subsidence |
8. Which can help reduce the risk of an earthquake?
- hazard maps
 - building resistant structures
 - Through effective earthquake instrumentation
 - All of the above
9. During large earthquakes, which is responsible for the greatest number of fatalities?
- drowning
 - fires
 - people buried alive
 - Large objects (buildings) fall on people

10.Which is not a cause of earthquake?

- A. movement of tectonic plates
- B. changing of soil density
- C. motion along earth's faults
- D. shifting of bedrocks

11.Accurate data gathering, recording and interpretation of data pertaining to ground shaking are all components of _____.

- A. hazard mapping
- B. earthquake instrumentation
- C. structural engineering
- D. none of the above

12.Which of the following is a primary hazard caused by an earthquake?

- A. cracks on the ground/ faults
- B. landslides
- C. liquefaction
- D. tsunami

13.When you are inside a building when earthquake begins, you should _____.

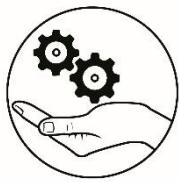
- A. Run outside immediately
- B. Duck, cover and hold on
- C. Go to an open space.
- D. Call your friends and relatives to let them know if you are okay or not.

14.Which can be prevented by reinforcing slopes and rerouting of water passages?

- A. landslide
- B. liquefaction
- C. subsidence
- D. tsunami

15.If you are at risk from earthquakes, what can you do to prepare for an earthquake?

- A. Choose a safe place in every room of your house like sturdy tables or desk.
- B. Develop a family disaster plan.
- C. Educate yourself on earthquake safety measures.
- D. All of the above



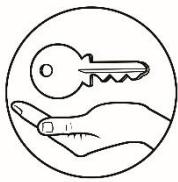
Additional Activities

Accurate information is one of the most powerful weapons in times of disasters. Your task is to make an informative, concise and attractive tri-fold brochure that contains information on earthquake risk reduction. Consider that the readers of the brochure are people from less-privileged areas.

Tri-fold Brochure Rubric

	Excellent (15-13 pts)	Good (12-10 pts)	Satisfactory (9-6 pts)	Needs Improvement (5-0 pts)
Organization of Information presented	Each section in the brochure has a clear beginning, middle, and end.	75% or more sections of the brochure have a clear beginning, middle, and end.	60% of the sections of the brochure have a clear beginning, middle, and end.	Less than half of the sections of the brochure have a clear beginning, middle, and end.
Content-Accuracy and Information validity	All facts in the brochure are accurate and match cited resources.	99-90% of the facts in the brochure are accurate.	89-90% of the facts in the brochure are accurate.	Fewer than 80% of the facts in the brochure are accurate.
Spelling & mechanics	No spelling errors and all sections of brochure are free of writing errors.	No more than 1 spelling and/or writing errors are present.	No more than 3 spelling and/or writing errors are present.	More than 3 spelling and/or writing errors are present.
Attractiveness & Organization	The brochure Has exceptionally attractive formatting and well-organized information.	The brochure has attractive formatting and well-organized information.	The brochure has well-organized information or format but not both.	The brochure's formatting and organization of material is confusing to the reader.
Graphics/ Pictures	Graphics match the topic and text in section where placed. Each section has no more than two graphics and there are at least a total of three graphics used.	Graphics go well with the text, but there are so many (more than two per section) that they distract from the text.	Graphics go well with the text, but there are too few (less than three graphics for entire brochure) and the brochure seems "text-heavy".	Graphics do not go with the accompanying text or appear to be randomly chosen.

Source: Tri-fold brochure rubric, Retrieved June 2, 2020,
http://mshartman.weebly.com/uploads/2/3/4/3/2343373/tri-fold_brochure_rubric.pdf.



Answer Key

What I Know		Assessment		What's More	
1. B	2. C	3. D	4. D	5. A	6. B
7. A	8. D	9. D	10. B	11. A	12. A
12. A	13. B	14. A	15. D	15. C	14. C

What's In
A. Fault - is a fracture or zone of fractures between two blocks due to ground movement. B. Epicenter - is the point on the earth's surface directly above the focus C. Focus - is also known as hypocenter; it is the origin of the earthquake. D. Fault line subsurface - a fault below the ground.

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For inquiries or feedback, please write or call:

Department of Education - Bureau of Learning Resources (DepEd-BLR)

Ground Floor, Bonifacio Bldg., DepEd Complex
Meralco Avenue, Pasig City, Philippines 1600

Telefax: (632) 8634-1072; 8634-1054; 8631-4985

Email Address: blr.lrqad@deped.gov.ph * blr.lrpd@deped.gov.ph