Learning Physics in the Context Of Disaster Risk Reduction

Ariane Joy B. Macinas
Bicol University, Philippines
arianemacinas30@gmail.com

Abstract - This study aimed to develop lessons from Grade 7 Physics with the integration of Disaster Risk Reduction (DRR) concepts as its main feature and determine the students' manifestations of learning along understanding of Physics concepts, DRR awareness, and 21st Century competencies. It also aimed to determine insights drawn from the students' experiences. Descriptive developmental research method was utilized in the collection and analysis of data. Seven lessons were developed which covered topics on Describing Motion and Waves. The lessons highlighted the following features: integration of DRR concepts, use of inquiry-based approach, contextualization to local experiences, and presence of the 21st Century competencies. After the implementation of the lessons, results revealed that the students' understanding of Physics concepts was enhanced with a mean gain of 7.70, and an increase in their performance level from 24% (Low Mastery) to 44% (Average Mastery). Results further revealed that there was an increase in the students' DRR awareness, in terms of knowledge and skills. They also exhibited communication, collaboration, creativity, and critical thinking skills in performing DRR-related activities in the lessons. Moreover, the lessons enabled the students to realize the relevance of Physics in their everyday lives and the importance of being aware and prepared for any emergencies and disasters.

Keywords - learning physics, disaster risk reduction, Physics conceptual understanding, DRR awareness, 21st century competencies

Introduction

Physics is one of the core subjects in science taught at the secondary level. It is the most basic and fundamental natural science which encompasses the study of the universe and allows us to understand natural phenomena around us like the colors of the rainbow, natural hazards, and disasters such as the production of lightning and thunder, the erratic changing temperature of our surroundings, tsunamis, earthquakes, cyclones, and many other natural phenomena. This essentially helps in the observation and exploration of the world that lead to great discoveries which change our lives. However, even with the significant contributions of Physics, there are still challenges faced in teaching and learning the subject. Based on thorough research studies, many students think and say that "Physics is difficult" (Fariñas & Budiao, 2017). Abstract concepts in Physics courses are very difficult for students to understand the subject (Tural, 2013). At the same time, according to Wieman and Perkins (2005), students see Physics as "less connected to the real world, less interesting, and more as something to be memorized without understanding". In general, students do not relate the subject to their lives making Physics difficult to understand. These pass a challenge for Physics teachers to enhance student understanding and persuade them about the necessity of learning Physics.

To help students better understand Physics, comprehend its relevance, and promote its value (Del Rosario, 2009), researchers from Physics Education Research (PER) suggest enhancing learning by using a variety of teaching strategies which allow students to learn to do Physics and contextualize it (MacLeod, 2012). These teaching strategies include inquiry-based approach and contextualization. In the inquiry-based approach, lessons are stimulated by a question or issue that involves students in constructing new knowledge, and meaningful understanding of concepts and applications to real-life situations. Likewise, contextualized lessons allow students to understand the concepts more readily and construct relevance within the context of their own experiences. Science, technology, society, and environment (STSE) is another approach to contextualize teaching in Science (MacLeod, 2012). STSE approach engages students in examining a variety of real-world issues and recognizing scientific knowledge as fundamental in such realities. It is in these perspectives that this study focused on developing Physics lessons in the context of Disaster Risk Reduction (DRR) to increase the students' understanding of Physics concepts. These will present to the students the significance of learning Physics by edifying on them the contexts that Physics has with real-world issues, like DRR, and its applications.

DRR is one of the issues most discussed around the world since our world is exposed to and affected by continual hazards and disasters. Developing Physics lessons in the context of DRR will provide significant applications and contributions of the subject to DRR and lead to meaningful learning among students. Learning Physics in the context of DRR can also play a vital role in the development of a risk-smart and disaster – prepared culture and society. Insights into the Physics of natural phenomena can contribute to DRR by informing society and policymakers. Students, as members of the society, must participate in understanding Physics to be aware of and be prepared in meeting the challenges of natural disasters. Learning Physics in the context of DRR will play a great part in transpiring awareness about DRR among the large population of the society, especially to the students who are amongst the most vulnerable to disasters.

In the Philippines, efforts on the integration of DRR in the education sector were already initiated. The Department of Education (DepEd) through the 2007 issuance of DepEd Order No. 55, s. 2007, prioritizes the mainstreaming of DRR Management in the School System and the implementation of programs and projects relative to it. One of the activities undertaken is the integration of DRR on lessons through existing subjects which is more effective than creating a new subject. However, according to Regala (2014), in the City Division of Legazpi, there is a very weak integration of DRR foci by teachers in their lessons. The results create a big threat to the students and the entire community for they will lack awareness and preparedness about disasters and its risk to the community.

Disaster Risk Reduction (DRR) concepts can be integrated in any subjects to help in promoting disaster resilience among students and other members of the society. Physics, as fundamental natural science, can help the students to understand the natural phenomena around us and can provide contributions to DRR. Thus, this study can aptly address the mandates regarding the integration of DRR by developing lessons in Physics in the context of DRR for the grade seven students of Pag–asa National High School (PNHS). PNHS is one of the urban public schools comprising a very large population of 3,412 students. It is found in Rawis, Legazpi City, a barangay in the province of Albay which is periodically affected by typhoons. Of the 19 to 21 occurrences of typhoon per year in the country, three (3) to five (5) of these directly hits on the Province of Albay (Salceda, 2013). The province experiences and is found to be very high-risk in terms of natural disasters like typhoons, temperature increase, El Niño, earthquake-induced shallow landslides, earthquakes, tsunami, and volcanic eruptions (Manila Observatory, 2009). In view of this, it is necessary for the students to become aware of the risks that they may face in the coming days and learn how to become risk-smart, prepared, and resilient.

Learning Physics in the context of DRR seeks the aim of science education which is to promote students' scientific literacy and citizenship by equipping them the knowledge and skills to make judgements and decisions that may have social, health, or environmental impacts (Department of Education (DepEd), 2013) and recognize that science occurs within a social-cultural context (MacLeod, 2012). Furthermore, it is underscored by the following considerations: (1) the importance of the students' understanding of the applications and relevance of Physics, (2) the advantages of the constructivist approach to improve students' understanding in Physics, (3) the importance of the students' understanding of DRR concepts, and (4) the importance and necessity of integrating DRR concepts into Physics. Situating Physics in the context of Disaster Risk Reduction will provide meaningful learning opportunities that will help students enhance their understanding of Physics concepts and at the same time raise their awareness on Disaster Risk Reduction for the development of a risk-smart and disaster-prepared society.

Materials and Methods

Descriptive developmental research method was used in the collection and analysis of data. Seven Physics lessons were developed and went through content validation by five (5) experts in the field of Physics education in terms of the following criteria: (1) consistency of objectives, activities & assessment, (2) correctness of Physics concepts, and (3) presence of the features. These lessons were implemented to determine the manifestations of learning along the students' understanding of Physics concepts, DRR awareness, and 21st century competencies. The students' insights derived from their engagement during the conduct of the developed lessons were also determined. These includes students' thoughts and ideas about the application of Physics concepts and appreciation of the Disaster Risk Reduction integration in the Physics lessons.

This study employed a single group pretest – posttest pre-experimental design. Pretests was first administered to one Grade 7 class of Pag-asa National High School (PNHS), during the school year 2018 – 2019, prior to the introduction of the intervention. These pretests include the conceptual understanding test, critical thinking test, and the DRR awareness self-assessment checklist. The group was then exposed to the developed Physics lessons with its features. After the intervention, the posttests were administered to the group as well. The comparisons made between the pretest and posttest results, through obtained mean, determined how the developed lessons enhanced students' understanding of Physics concepts, DRR awareness, and critical thinking (21st century competencies). Additionally, ratings from the observation checklists, as well as the students' outputs, journal entries, and inputs from the focus-group discussion were utilized and analyzed to determine and measure the students' manifestations of learning and insights.

Results and Discussions

Developed Physics Lessons with its Features

This study covered the development of seven (7) Physics lessons with the topics on Describing Motion and Waves. The seven lessons are (1) Position and Reference Point; (2) Distance and Displacement; (3) Speed; (4) Velocity; (5) Acceleration; (6) Waves and Energy; and (7) Wave Characteristics. The validated lessons followed the daily lesson log (DLL) format which was provided by the Department of Education (DepEd). Each lesson has the following essential parts: unit title, topic, time frame, objectives, content, learning resources, and lesson procedures. It also used the 7 E's Instructional Model which is the recommended instructional model in the K-12 science curriculum. The lesson procedures consist of seven (7) phases of learning: Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend. The contents of each lesson like the unit title, topic, learning competency, concepts, and time frame were based from the K to 12 Science Curriculum Guide and modules in the DepEd Grade 7 Learner's

Manual and Teacher's Manual. The developed lessons also featured the (A) integration of Disaster Risk Reduction concepts, (B) use of inquiry-based approach, (C) contextualization to local experiences, and the (D) presence of 21st century competencies.

A. Integration of Disaster Risk Reduction concepts

Taking into account that students are the most vulnerable to disasters, and the important role that schools play in spreading awareness and the formation of values, this study covered the development of Physics lessons integrated with Disaster Risk Reduction (DRR) concepts, as a main feature. The lessons primarily aimed to let the students understand Physics concepts and at the same time raise their awareness along DRR. This study supports the claim of Whitelegg and Parry (1999) which states that "we can enhance learning Physics while enhancing environmental awareness by choosing a context for learning that meets society's as well as students' needs". Recognizing this, the teacher-researcher utilized Disaster Risk Reduction concepts into the Physics lessons thereby promoting understanding of Physics concepts and DRR awareness among the students. Table 1 shows a summary of the seven (7) Physics lessons integrated with Disaster Risk Reduction Concepts.

Table 1. Matrix of the developed Physics lessons integrated with DRR concepts

Topic	DRR Concept Integrated
Position and Reference Point	▪ Locating and identifying resources and capacities found in the school and community, that can help in preparing for potential accidents, hazards, or disasters in school and community. ▪ What to do before (preparedness and mitigation) and during (response) a human-made and natural hazard. ▪ What to do after (rehabilitation) an earthquake, and an accident.
Distance and Displacement	▪ Need for emergency evacuation plan in schools showing exit routes for safety, in case of disasters. ▪ Use of typhoon tracking map in reading map coordinates, use of scales to locate the position of a typhoon, and to trace its motion. ▪ Resources and capacities (APSEMO, PNP, Fire Station, etc.) located in the city that can help prepare for potential accidents, hazards, or disasters in school and community. ▪ Importance of knowing Permanent Danger Zone (PDZ) around disaster prone areas ▪ Community risk and resource map about hazards, vulnerabilities and capacities found in the community.
Speed	▪ Promoting road safety focusing on the dangers of over speeding. ▪ The viscosity, rate, and speed of the two types of lava flow that a volcano can eject. ▪ Classification of tropical cyclones according to the speed of their circulating winds.
Velocity	▪ Tropical cyclones: Typhoon tracking / weather forecasting and overview of the severe weather bulletin of PAGASA. ▪ What to do before a typhoon for preparedness and mitigation.
Acceleration	▪ Understanding the motion of typhoons and its importance to typhoon forecasting. ▪ Understanding the motion of tsunami waves.
Waves and Energy	▪ The potential risks brought about by the waves produced by earthquakes. ▪ The three types of earthquake waves (in terms of motion of particles). ▪ Ways on how to mitigate and prevent the destructions and damages caused by earthquakes
Wave Characteristics	▪ Overview about the seismograph and seismometer. ▪ Characteristics of the three types of earthquake waves (in terms of speed, and energy). ▪ The potential risks brought about by big waves like earthquakes and ways on how to mitigate and prevent the destructions and damages they cause. ▪ Overview about tsunami: its causes, energy, and speed.

In general, the developed lessons in Physics mainly integrated DRR concepts of natural hazards like landslides, tropical cyclones, lava flow, earthquakes, and tsunami waves. Likewise, the lessons also included human-induced hazards like fire, and road / vehicular-related accidents. Concepts about identifying vulnerabilities, resources and capacities were also integrated within the lessons. Including these DRR concepts across Physics lessons can contribute to the enhancement of student learning and in building disaster preparedness and a "culture of safety and prevention". This feature can allow students to be engaged in examining various

concepts in DRR like understanding the science and mechanisms of 'natural' disasters and recognize that Physics is fundamental in understanding such mechanisms. For instance, lesson 4 tasks students to track and forecast the motion of a typhoon and this can be done by understanding the concepts of position, displacement, speed, and velocity. With this, the lessons can encourage students to actively involve themselves in inquiry and discussion of Physics concepts. This is supported by the UNESCO and UNICEF (2014) which states that learning should move towards engaging students in active inquiry, experimentation, analysis, and discussion to enrich understanding of such mechanisms.

The links made between Physics and DRR concepts allow the enhancement of the students' learning in Physics and DRR awareness. The lessons follow a constructivist teaching approach which supports student learning based on their disaster-related experiences and ideas. Constructivism suggests that students construct knowledge and meaning from their experiences. In this study, students learn by fitting what they have learned together with what they already know and experience. Teaching the Physics concepts behind the disasters that they commonly experience in their locality provides opportunities for students to reconcile their new learning with their previous ideas and experiences that are related to hazards and disasters.

B. Use of inquiry – based approach

In this study, the inquiry-based approach was utilized in the lesson proper by employing the 7Es Instructional Model. The tasks within the 7Es lessons aim to let the students discover the concepts about motion and waves on their own. The 7E Instructional Model is composed of the following parts: Elicit, Engage, Explore, Explain, Elaborate, Evaluate and Extend. Table 2 presents the inquiry-based tasks presented in the lessons.

Table 2. Matrix of Inquiry-based Tasks

Topic	Inquiry-based Tasks/Activities
Position and Reference Point	▪ Describing the position of objects and places by using magnitudes of the measured paths and directions.
Distance and Displacement	▪ Exploring and measuring the distance and displacement of the school's emergency assembly area from their classroom and investigating how the two physical quantities differ.
Speed	▪ Discovering the relationship of distance and time in measuring the speed.
Velocity	▪ Tracking the motion of a typhoon and discover how velocity is different to speed. ▪ Determining the movement of a typhoon and forecast its landfall on different areas of Luzon.
Acceleration	▪ Exploring how a typhoon's motion change in terms of its speed, direction, or both (velocity).
Waves and Energy	▪ Observing, drawing, and describing how waves are produced and identifying the its types according to the direction of vibrations of particles with respect to the direction in which the waves travel.
Wave Characteristics	▪ Identifying the quantities used in describing a periodic wave and relating one quantity to another.

The seven lessons used various tasks like using pictures, videos, asking questions, recalling understanding from the past lessons, and using examples that are available to their surroundings and related to real-life situations. Specifically, the Explore part of the lessons provided opportunities for the students to participate in inquiry-based activities. The activities are commonly designed using the structured and guided levels of inquiry. For the structured activities, the students are tasked to investigate on teacher-presented questions through prescribed procedures while in the guided-inquiry activities, the methods and solutions are open to the students for the investigation of teacher-presented questions. In general, the different tasks and inquiry questions provided in all lessons help in guiding the students in the investigation of Physics concepts and allow them to become more involved and have direct roles in their learning.

C. Contextualization to local experiences

The seven developed lessons in Describing Motion and Waves also feature contextualization which was basically integrated in the different parts of the 7Es lesson plan. With this feature, this study aimed for the students to understand the connections of the presented Physics concepts to real-life situations. As recommended by Bornilla (2016) in her study, teachers should contextualize lessons and activities to enhance students' understanding of abstract concepts in science. Table 3 presents the contexts of local experiences integrated in the seven lessons.

Table 3. Matrix of contexts of local experiences integrated in the lessons

Topic	Contexts of Local Experiences
Position and Reference Point	▪ Applying concepts to real-life: The places found inside the school ground like the clinic, guidance office, guard house, the main gate was used in the activity. ▪ Places commonly found in the community like barangay hall, school, church, hospital etc., were used in the examples and problems.
Distance and Displacement	▪ The PNHS school map/directory and animation of a tricycle passing outside the school were used to recall the previous lesson. ▪ The PNHS emergency evacuation plan was used in the activity. ▪ Familiar landmarks and places found in Legazpi City were used in the exercises provided. ▪ Different areas in Legazpi City like Buyuan, Matanag, Mabinit,etc. were presented showing their distance from the crater of Mayon Volcano. ▪ Construction of community maps from different barangays for the application of the concept.
Speed	▪ Contextualized situation: A student is worried about the cars rushing by when she walks the street of Pag-asa road to go to school. ▪ Use of familiar objects observed in the locality like cars, tricycles, and motorcycles. ▪ Contextualized problem related to an instance of a volcanic eruption of Mayon Volcano and to the permanent danger zones in Legazpi City. ▪ Local and familiar events and places like the 2018 Mt. Mayon Triathlon Cup in Albay, PNHS, and Pawa were used in the problems.
Velocity	▪ Events that happened in the locality like landfall of typhoon Glenda was present in the given examples. ▪ The map of Luzon, including areas in Bicol like Legazpi City and Virac, was used in the typhoon tracking and mapping activity. ▪ Weather forecasting activity contextualized in Legazpi City.
Acceleration	▪ Contextualized problems: Use of events that happened in the locality like the typhoon Glenda, typhoon Ompong, vehicle observed in the locality, jeepney, and the tsunami news and warnings declared in Legazpi City were cited in the problems.
Waves and Energy	▪ Contextualized activities: Materials and places, commonly found in the students' surroundings, were used in the tasks like the Rawis beach, school bell, television, sun, drum & drumsticks. ▪ The concept of the earthquake was used in the application of concepts.
Wave Characteristics	▪ The tsunami warning issued in Legazpi City during the 2011 earthquake in the coast of Japan was included for the application of concepts.

The lessons used contextualization within the different parts of the lessons through the use of objects, places, events, and situations that are commonly found, observed or experienced by the students within the locality. Contextualization in the Engage portion of the lessons also helps in the presentation of a new lesson or topic. For instance, the new topic for lesson 3 was presented using a letter. The letter presents a situational example where a student is worried about the cars rushing by when she walks the street of Pag-asa road to go to school. This is a common scenario observed and experienced by most of the students in PNHS. With the presentation of this situational example, the students can become more engaged and interested in learning the concept of speed.

All lessons were also contextualized in the Elaborate portion of the lesson. It is expected since applications of the lessons to daily life are usually included in this portion. Eisenkraft (2003) stated that in this part of the lesson, students should be assisted to elaborate on their learning experiences and transfer their knowledge by extending these ideas to new areas. In the case of this study, the lessons elaborated the Physics concepts into real-life situations and DRR experiences. For example in lesson 7, the concept of wave characteristics was elaborated and connected to the understanding of the mechanisms of a tsunami. The Elaborate portion of the lesson was contextualized by recalling the tsunami warning issued in the area of Legazpi City during the 2011 earthquake in the coast of Japan. Specifically, this question was asked in the lesson: "The tsunami strike shown gave a tsunami warning in the different areas of the world and in the Philippines, including Legazpi City, Albay. Why do you think tsunami warnings were raised in other areas and not only in Japan?" This example was used so that students will be able to relate their understanding that waves move away from the source and travels in all directions. In addition, it was also expected that the students will be able to cite the application of wave characteristics in understanding mechanisms of tsunami waves.

The contextualized lessons may urge the students to cite some situations in their locality which they can use to better understand the concepts in Describing Motion and Waves. With the presence of contextualization in the different parts of the lessons, the students are given the opportunity to make their learning meaningful by connecting their experiences to the concepts being introduced to them. This feature leads the students to realize that Physics concepts are not too difficult for them and need not be memorized for they are important in their day-to-day living.

D. Presence of the 21st century competencies

The last feature highlighted is the presence of the 21st century competencies which specifically focuses on the 4Cs of learning. The 4Cs of learning are collaboration, communication, creativity, and critical thinking. Each of the parts in the 7Es lessons can be used to teach each of the 4Cs. The 4Cs are presented with the aid of the different tasks present in each of the phases in the 7Es lessons. In general, the lessons provide learning opportunities where students will work and perform activities in groups and eventually promote collaboration. The developed lessons in this study commit the students to activities where they need to work in small collaborative groups that will help them in building such good collaboration skills.

Also, the lessons generally provide learning opportunities where students can utilize and enhance their communication skills. For instance, through brainstorming, each member will be given the opportunity to ask questions and share his insights, ideas, and solutions about the concepts related to the activity. It is important to note that collaboration and communication are interpersonal skills that go together when people work with one another. Hence, the lessons provided in this study can help students to enhance their working relationships as well as promote effective communication.

The lessons also intend to make students become creative and critical thinkers. The activities present in the developed lessons can encourage students to develop their personality and thinking/working styles like showing a high degree of curiosity, and willingness to take chances, defend ideas, experiment, and predict. In addition, given the different tasks and activities that the students need to perform, they had the opportunity to apply critical thinking skills by inquiry and to look for possible answers to the given questions in the activities.

Students' Manifestations of Learning

Aside from the development of Physics lessons with DRR integration, the study also aimed to determine outcomes in terms of the students' learning. One way to gauge this was to determine the manifestations of learning observed from the students along their understanding of Physics concepts, DRR awareness, and 21st century competencies. The observations, students' written outputs, journals, and inputs from the focus-group discussion, and photos were utilized for qualitative evaluation to determine the students' manifestations of learning during the conduct of the developed lessons. The results from the conceptual understanding test, DRR awareness self-assessment checklist, and critical thinking test were also evaluated quantitatively to find out and verify the learning manifestations of the students along their understanding of Physics concepts, DRR awareness and 21st century competencies.

A. Understanding of Physics concepts

The students' understanding of Physics concepts was measured based on the results of the Conceptual Understanding Test administered before and after the conduct of the study. This 40-item multiple choice type of test was used to gauge the content knowledge of students on the topics on Describing Motion and Waves. The mean percentage score (MPS) was computed to measure the proficiency level of the students in the pretest and posttest. The performance of Grade 7 students in pretest and posttest increased in the mean gain and as well as in the MPS of all competencies. The mean score in the pretest was 9.73 while in the posttest was 17.42 which gained an equivalent mean of 7.70 and corresponding to a MPS gain of 20. This indicates that there is a positive increase in the conceptual understanding of grade 7 students in Describing Motion and Waves after the use of the lessons. Result also shows that positive gain scores are achieved in the six competencies. The performance level of the students improved from 24% (low mastery) to 44% (average mastery). For all competencies, the movement is from low mastery to average mastery which implies that the learners have improved their understanding of the concepts anchored on the six competencies after the conduct of the lessons.

This increase in the conceptual understanding may have been achieved through the aid of the different features used in the lessons. Manifestations of students' understanding of concepts were mostly observed from the performance of students during the inquiry-based activities. The activities provided in the lessons gave opportunities for students to construct their own knowledge and understanding of the presented concepts. It can also be inferred that the integration of the DRR concepts helped the students to relate the Physics concepts they have learned to areas like DRR. The students' answers from the FGD and journal show that they were able to acquire an understanding of Physics concepts by linking and seeing the relationships of the concepts they have learned to DRR. Furthermore, the 21st Century competencies present in the lessons helped students develop understanding of Physics concepts. For example, the collaboration among students helped them to enhance their conceptual understanding because they were able to listen, share, and support ideas with their group mates.

B. Disaster Risk Reduction (DRR) awareness

Learning manifestations of students' awareness on Disaster Risk Reduction were gauged based on the results gathered from the DRR Awareness Self-Assessment Checklist. The statements included in the self-assessment checklist specifically measured students' awareness in terms of their DRR knowledge and DRR skills. Table 4 shows the summary of the mean scores from the pretest and posttest on DRR Awareness. In general, the DRR awareness of the students was enhanced after the conduct of the study. From a general mean of 2.22, it increased to 4.02 which resulted in a mean gain of 1.8. This shows that the students' DRR awareness

were described as "slightly aware" before the conduct of the lessons, while after the implementation, the students were "moderately aware".

Table 4. Students' Disaster Risk Reduction (DRR) awareness

	Mean (Pretest)	Description	Mean (Post Test)	Description
DRR Knowledge	2.08	Slightly Aware	3.94	Moderately Aware
DRR Skills	2.87	Somewhat Aware	4.36	Moderately Aware
GENERAL MEAN	2.22	Slightly Aware	4.02	Moderately Aware

The increase in the students' awareness can be attributed to the DRR-related concepts, tasks, and activities integrated within the lessons in which they participated actively. Several manifestations of students' DRR awareness were observed based on the observations, students' outputs, FGD, and journal entries. For instance, lesson 2 entitled Distance and Displacement enabled the students to become familiar with the permanent danger zones included during the eruption of Mayon Volcano. Furthermore, the Community Risk and Resource Mapping activity embedded in the lesson involved the students in surveying and identifying areas of their barangay that are prone to disasters. For example, students identified barangay San Joaquin as an area that is prone to flooding. These activities provided in lesson 2 involved the students to survey and identify disaster prone areas found in their barangays and familiarized their selves of the areas included in the permanent danger zones of Mayon Volcano. The integration of DRR concepts in the Physics lessons enabled students to actively participate in tasks and activities that engaged them in disaster risk reduction. Through the developed lessons, the students were exposed to different DRR concepts that eventually transpired DRR awareness among them.

C. 21st Century Competencies

Learning manifestations of the students along the 21st century competencies were also identified using observations, students' journal entries, outputs, and answers from the focus-group discussion. The students' manifestations of communication, collaboration, critical thinking, and creativity skills or also known as 4Cs were determined based on their performances during the conduct of the lessons. Collaboration and communication skills among students was observed during the conduct of all lessons since most of the activities were designed for group work. It is noted that collaboration and communication goes together when people work with one another. During the activities, as they worked and collaborated with their groupmates, it was observed that they communicated and interacted with one another to effectively share their opinions and ideas. They were given the chance to speak, share ideas with each other, compromise, and respect everyone's opinion. During the activities, the students were most of the time divided into five groups. They performed the different activities, answered the questions provided in the activity sheets, and presented their work orally, in written forms, and illustrations.

Stimulating students' curiosity is one of the ways to promote students' learning and creativity. During the activities, the students demonstrated curiosity by asking questions to their classmates and teacher. In addition, it allowed students to generate their own ideas to answer and complete the tasks given. For example, the activities in lesson 1 enabled the students to perceive the problem in several ways. Based on the outputs provided by the students, they used their own approaches to answer the single problem provided in the activity. They independently decided on how they will conduct their investigations and answer the problems. In general, the students approached the problems in the activities in several different ways. Lastly, given the different constructivist tasks and activities that the students performed, they also became critical thinkers by inquiring and looking for possible answers to the given questions in the activities. This was also reflected on the students' answers from their journals, outputs, focus-group discussion, and critical thinking test. Students were able to analyze variables for problem-solving by asking inquiry questions and make justifications of the concepts they have learned.

A 6-item critical thinking test was also administered before and after the conduct of the lessons to gauge students' critical thinking skills. The performance of Grade 7 students in the pretest and posttest increased from a pretest mean score of 1.64 to a posttest mean score of 8.94. This resulted to an equivalent mean gain of 7.30. This indicates that there is a positive increase in the critical thinking skills of grade 7 students after the use of the lessons. The items included in the critical thinking test specifically measured different areas of critical thinking, like reasoning, hypothesis testing, argument analysis, and problem-solving and decision-making. The highest mean gain attained by the students was on the area of problem-solving and decision-making.

To sum up, different manifestations of students' learning were identified in terms of their understanding of Physics concepts, DRR awareness and the 21st century competencies. The students' understanding of Physics concepts and DRR awareness were enhanced after the conduct of the developed lessons. Likewise, the implementation of the developed lessons promoted the students' collaboration, communication, creativity, and critical thinking skills. The discussed manifestations of students' learning were

supported by the results of the mean gain, observations, students' outputs, journal entries, focus-group discussion, and related studies.

Students' Insights Derived from their Engagement in the Developed Lessons

Insights were determined based from the students' thoughts and ideas about their engagement during the implementation of the developed lessons. After the implementation of the seven developed lessons, the students were able to identify applications of Physics concepts. Questions were given in the journals and during the focus-group discussion to which students input their insights about the application of Physics concepts. The following insights on application of Physics concepts were gathered: (1) the Physics lessons were interesting and fun since the students can apply the Physics concepts to DRR and every-day life activities and experiences; (2) the Physics lessons were familiar since the students can relate them to everyday situations and experiences, as well as to the changing motion of typhoons; and (3) the Physics lessons are important since it can be applied in Disaster Risk Reduction and in understanding DRR-related concepts.

All insights discussed served as evidence that the different features in the lessons allowed the students to connect their learnings in Physics to their everyday lives and to disaster risk reduction. It can be concurred that the features integrated in the lessons promoted students' learning and enabled the students to determine the relevance of Physics in their everyday lives. Aside from the students' insights on the applications of Physics, their insights in terms of their appreciation of DRR integration in the Physics lessons were also gathered. It was revealed in the previous discussion that the use of inquiry-based approach, the integration of Disaster Risk Reduction concepts and contextualization on the lessons helped the students make connections of the Physics concepts to their lives. Likewise, the integration of Disaster Risk Reduction concepts in the lessons may also have offered insights to the students about their appreciation of Disaster Risk Reduction integration in the Physics lessons.

The statements and insights shared by the students imply that the students are not just willing to learn Physics, but they also want to become involved in disaster risk reduction. Their insights may indicate that they felt the sense of responsibility to help and protect their selves, peers, and family. In general, the following insights on appreciation of DRR integration in the lessons were gathered: (1) the integration of DRR concepts in the lessons helped the students to gain more knowledge about disaster risk reduction; (2) the developed lessons integrated with DRR concepts made the students feel happy, safe, and prepared; and (3) the students preferred to learn Physics with the integration of DRR concepts. All insights discussed served as evidence that the integration of DRR concepts in the lessons allowed the students to appreciate its importance.

Conclusion

Seven (7) lessons under Unit 3, Modules 1 and 2 of the curriculum guide for grade 7 Physics were developed. The following features were highlighted: integration of DRR concepts, use of inquiry-based approach, contextualization to local experiences, and presence of 21st century competencies. Overall, the features of the developed lessons have notably influenced students learning. Manifestations of learning were identified along students' conceptual understanding, DRR awareness, and 21st century competencies based on the conceptual understanding test, DRR awareness self-assessment checklist, critical thinking test, and observation checklists. Moreover, insights were also drawn from the students which generally implies that the lessons integrated with the different features and activities helped the students to realize the applications of Physics to their everyday lives and in DRR, as well as appreciate the importance of Disaster Risk Reduction in their lives.

The overall findings suggest that the developed lessons may be adopted by grade 7 teachers in public and private schools to improve the level of implementation of mainstreaming disaster risk reduction in secondary schools. Teachers should be encouraged to integrate DRR concepts to make learning more interesting and improve conceptual understanding and DRR awareness. The lessons can also be modified and improved to enhance students' learning in Physics or as the need arises. Teachers should integrate Disaster Risk Reduction concepts along with the various inquiry-based activities and contextualized teaching strategies to further enhance students' conceptual understanding, DRR awareness, and 21st century competencies.

Acknowledgement

The researcher would like to express her heartfelt gratitude to the Department of Science and Technology – Science Education Institute, headed by Dr. Josette Biyo, for giving her the opportunity to be a scholar under the National Consortium for Graduate Science and Mathematics Education that helped the researcher financially; to Bicol University Graduate School for the assistance in pursuing this study; to her thesis adviser, Dr. Lorna M. Miña, for the guidance, encouragement, time and commitment to assist the researcher throughout her thesis writing journey; and to her family for the untiring support.

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