Level of Content Knowledge and Critical Thinking Skills of Senior High School STEM Students in Disaster Readiness and Risk Reduction

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Abstract
Disasters are sudden disruptive event which affect the functioning of a community in utilizing its own resources. This make disaster readiness and risk reduction a current trend in science teaching to match the needs to the fast-paced advancements which will provide many social benefits. This descriptive research study determined the level of content knowledge and critical thinking skills of Senior High School STEM students in Disaster Readiness and Risk Reduction (DRRR), their notable experiences, values and attitudes developed among the schools in Albay, Philippines based from their political subdivisions and topographical locations. It was concluded that the level of content knowledge of the students in DRRR before the lessons were in low mastery level while urban lowland schools were in near mastery level. For the level of critical thinking skills, all schools were in low mastery level. After the lessons, the level of content knowledge of the students from all schools significantly increased wherein, they were already in the mastery level except the urban lowland schools with full mastery level. The level of critical thinking skills of all the schools significantly increased from low mastery to mastery level. Students developed a sense of awareness with regards to the DRRR concepts which could be associated to the student's experiences Positive values and attitudes were also developed after the conduct of the lessons. All of these were supported with percentage scores in the tests, ANOVA, tukey test, paired T-test, student journals, teachers' observations and documentations.

Keywords: Biology Education, Content Knowledge and Critical Thinking Skills of Senior High School STEM Students,Disaster Readiness and Risk Reduction, Descriptive Research, Philippines/Asia

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Introduction

There is an increasing knowledge that due to human activities, environmental factors such as volcanoes, natural processes and natural hazards are becoming disastrous events (DepEd, 2015). The needs of the people from the affected area such as relief operations, evacuation centers, proper sanitation, water supply, health assistance, a permanent monitory and warning systems to assess natural disasters in real time, 24 hours a day were established by both concerned government and non-government offices. Aside from those basic needs, according to the Volcanic Disaster Assistant Program (VDAP) established by the United States Agency for International Development (USAID) in partnership with the US Geological Survey (USGS); the Disaster Readiness and Risk Reduction (DRRR) education maybe the most feasible way to reduce the hazard. According to the DepEd K-12 curriculum, the Philippines is frequently cited as among the top countries most at risk to disasters. While disasters can arise from manmade sources, the most inevitable ones come from natural phenomena, even without scientific scrutiny. Every Filipino is familiar with the impact of typhoons, earthquakes, volcanic eruptions and fires to everyday life and to national development. This makes learning about disaster development aligned with everyone's interests. This will serve as an opportunity to make DRRR as a subject matter relevant to the lives of the people especially to the students even if studying disasters are part of learning the Sciences.

This study focused on determining the level of content knowledge and critical thinking skills of Senior High School STEM students in DRRR. It utilized researcher-made pre-test and posttest, evaluation instrument, observation guide and students' journals with guide questions to extrapolate the needed themes. Through the development of content knowledge, critical thinking skills, values and attitudes of students towards DRRR, students become more aware, prepared and resilient to the different natural hazards. This may also help teachers to improve and develop more teaching strategies to effectively impart the objectives and principles in teaching the subject matter such as reducing the damage caused by natural hazards, guiding and motivating students to seek answers or solutions from the given problem or contextual situation and simplifying knowledge or ideas about disaster readiness and risk reduction, allowing students to work with others and learn on their own, combining prior knowledge with new, and encouraging them to connect with the real world. Common scenarios become the basis for new information and encourage the learners to extend what they know.

This study will be beneficial to public high schools in Albay province both in urban and rural areas who offer DRRR as a core subject for Senior High School STEM students in order for them to learn how to be prepared in natural catastrophic events such as earthquake and volcanic eruption and realize the importance of the environment as a source of living.

Research Method

This study is a descriptive research which focused on determining the level of content knowledge and critical thinking skills of Senior High School STEM students in Disaster Readiness and Risk Reduction (DRRR). Both qualitative and quantitative methods were both utilized in descriptive research to generate information on the

status of a phenomenon to describe "what exists" with respect to the variables or conditions in a situation (Asaad et.al 2004). The goal of this type of research is to cast light on current issues or problems through a process of data collection that enables them to describe the situation more completely (Fox et.al, 2007). This method was also utilized to determine the notable experiences of the students during the lessons and the values and attitudes developed after the conduct of the lessons in DRRR.

The primary sources of data for this study were the results of the pretest/posttest of content knowledge test and critical thinking test from the 156 students from Rural-Coastal School, Rural-Upland 1 School, Rural-Upland 2 School, Urban-Coastal School, Urban-Lowland 1 School and Urban- Lowland 2 School as the respondent schools. Likewise, observation of teacher-observers, activity outputs, videos, photos and reflective journals of students were taken account for the notable experiences and developed values and attitudes.

Upon completing the research proposal, the teacher-researcher sent communication letters to the offices of the Schools Division Superintendents in the four division offices in Albay Province namely Tabaco Schools Division Office, Ligao Schools Division Office, Albay Schools Division Offices and Legazpi Schools Division Offices to access the lists of public high schools including the name of its school heads and principals in order to identify the possible respondent schools in which the researcher will implement the study (See Appendix F). There were 16 possible respondent schools identified in the said divisions. Based from the scope and delimitation of the researcher's study, only six schools were selected based on the political subdivisions (urban or rural), the land elevations (upland, lowland and coastal area) in which the data came from the Municipal or City Planning and Development Office where the schools from the different divisions offering STEM strands are located. There were three Rural-Upland Schools coming from Buga, Libon Albay, Banquerohan, Legazpi City and San Antonio, Tabaco City, one Rural-Lowland School coming from Salvacion, Daraga and one Rural-Coastal School coming from Malilipot, Albay. There was no Urban-Upland school offering STEM strand identified but there were nine schools identified coming from Daraga, Albay, Polangui, Albay, Sto. Domingo Albay, Guinobatan, Albay, Oro Site-Magallanes, Legazpi City, Rawis, Legazpi City, Bitano, Legazpi City, Guilid, Ligao City and Tuburan, Ligao City.

The selected respondent schools are: (1) Rural-Coastal School (RC) with 15 Grade 11 STEM Students coming from Albay Division situated at approximately 11 meters or 36 feet above mean sea level (2) Rural- Upland School 1 (RU1) with 20 Grade 11 STEM Students coming from Tabaco City Division situated at approximately 400 meters or 1312 feet above sea level. (3) Rural- Upland School 2 (RU2) with 19 Grade 11 STEM Students coming from Legazpi City Division situated at approximately 76 meters or 249 feet above sea level (4) Urban-Coastal School (UC) with 30 Grade 11 STEM Students coming from Tabaco City Division situated at approximately below 10 meters or 32 feet above sea level (5) Urban-Lowland School 1 (UL1) with 37 Grade 11 STEM Students from Legazpi City Division situated at 4.8 meters or 15.7 feet above mean sea level and (6) Urban-Lowland School 2 (UL2) with 35 Grade 11 STEM Students coming from Ligao City Division situated at

approximately 48.2 meters or 158.1 feet above sea level. Complete enumeration or one intact Grade 11- STEM classes per school were selected as respondents.

According to the data collected from the Albay Provincial Disaster Risk Reduction Management Council (PDRRMC), to assist the local government's strategic decision making, the Philippine Institute of Volcanology and Seismology (PHIVOLCS) published updated hazard maps to help understand the risks related to the eruption. Malilipot, Ligao City, Tabaco City, and Legazpi City were considered at the six-km danger zone. Monsoon rains can exacerbate the danger to residents by causing flooding, landslides and lahar (mudflows), adding to the concerns of communities surrounding the volcano. Particularly the location of the respondent schools are considered to be prone to volcanic hazards (lahar, ash fall, lava flow and pyroclastic flow) floods and landslides. The two schools located in Coastal Area were considered to be prone to tsunami hazard but there was no record of occurrence yet.

Since 14 January 2018, Mayon Volcano had continued to show high levels of unrest resulting from repeated hazardous eruptions that displaced thousands of residents from the danger zones which implied that the people from Malilipot, Ligao, Tabaco and Legazpi City were involved. Through determining the level of content knowledge and critical thinking skills of the students, the researcher could assess how will the students be part of the community, could mitigate and minimize the loss of lives and properties associated with this event.

After the consolidation of the prior data, the researcher immediately sent letters of request to conduct the study in all the schools addressed to their respective principals (See Appendix G).

The teacher-researcher utilized the K to 12 curriculum guide for Disaster Readiness and Risk Reduction to develop the pre/posttest relevant to the learning competencies applicable for measuring the level of content knowledge and critical thinking skills of SHS-STEM students before and after the conduct of the lessons.

A request letter was sent to the experts who evaluated and validated the researcher-made pre/posttest, observation guide/checklist and students' journal. There were five validators per instruments and were provided by the instruments and validation forms with the corresponding content area which were the content knowledge and critical thinking skills. After the submission of the accomplished instruments, the raw data were transformed into weighted means with adjectival rating which was the basis for making the statistical tables for analysis and interpretation. After the validation of the instruments, all comments and suggestions that were made by the evaluators were used by the researcher for the instruments' validity and reliability. All experts taught DRRR or assigned as DRRR Coordinator in their respective schools.

Weighted Mean was used to determine the average views of experts on the test items and further interpreted using the scale below:

Description		Scale
Needs Improvement	-	1.00-1.49
Moderately Satisfactory	-	1.50 to 2.49
Satisfactory	-	2.50 to 3. 49
Very Satisfactory	-	3.50 to 4.49
Outstanding	-	4.50 to 5.00

After the approval of the request to the Schools Division Superintendent in the Schools Division Offices of Albay, Tabaco City, Legazpi City and Ligao City and respective principals, the researcher administered a pre-test, conducted the observation and gave the posttest. Before the conduct of the study upon approval, the researcher ensures that there were parents' consent form given (See Appendix H) to the respondents of the study which states that they allow their children to participate in the research study and if they are willing that their child will be taken pictures and videos during their DRRR classes.

The three observer-teachers (a principal or an assistant principal, a master teacher or a subject group head and a head teacher in Science) among the schools observed the one intact Grade 11 STEM classes all throughout their DRRR subject for the third quarter. The observation among the schools started from November 2018 until January 2019 and the DRRR teachers discussed the lessons or topics: (1) Introduction to Disaster Concepts (2) Concepts of Exposure and Vulnerability (3) Identifying Exposed elements (4) Introduction to different types of Hazards (5) Potential Earthquake hazards (6) Tsunami Signs (7) Earthquake Hazard Maps (8) Precautionary and Safety Measures for Earthquakes (9) Different Types of Volcanic Hazards (10) Volcano hazard Maps (11) Precautionary and safety Measures for Volcanic Eruption. The lessons presented by the teachers addressed the content standards identified by in DRRR curriculum guide as a subject matter which helped the students apply ideal responses to prevent disasters towards the end of the subject and will focus on the applications of which to the community and the Philippine society.

The students wrote to their journals as their task right after every lesson. This became the basis of the researcher in identifying the effect of the lessons in the content knowledge, critical thinking skills, notable experiences and values and attitudes which does not affect their grades. The gathered data in the students' written reflections on their journal serve as qualitative data to support the findings on the effect of the inquiry-based lessons on the students' content knowledge, critical thinking skills, notable experiences values and attitudes.

Statistical Treatment of Data

To provide reliable answers to the problems cited, the data gathered were subjected to statistical treatment.

Weighted Mean was used to average the five-point scale ratings of experts in evaluating the content knowledge pre/posttest, critical thinking skills pre/posttest, observation guide and students' writing journal as instruments in the study.

One-way ANOVA was used to determine the level of content knowledge and critical thinking skills among the students before the conduct of lessons.

Two- way ANOVA was used to determine the level of content knowledge and critical thinking skills among the students after the conduct of lessons.

Tukey test was used to determine the significant differences among the schools in terms of the level of content knowledge and critical thinking skills before and after the conduct of lessons.

Paired t-test was used to determine the significant differences of pre-test and post test results of content knowledge and critical thinking skills of the class.

Kuder-Richardson Formula 21 was used to test the reliability of the pre-test. This can be thought of as a measure of the extent to which the items on a test provide consistent information about students' level of knowledge of the content assessed by the test.

Percentage scores were used in profiling the scores of the students in the multiple choice for content knowledge. General percentage was also utilized to determine the grades of the pretest and posttest.

Conclusions

Based on the analysis of data gathered in the study, the following findings are derived:

1. The level of content knowledge of senior high school students before the conduct of lessons in Rural and Urban schools had a general percentage of 49.99 which indicated a low mastery level in all the content or topics and with a p-value of 0.01 which means that there was a significant difference among the schools at alpha level 0.05. Using the Tukey test, it was found out that there were significant differences among the schools particularly in Rural-Coastal School and Urban-Lowland School 2, Rural-Upland School 2 and Urban-Lowland School 2 , Urban-Coastal School and Urban-Lowland School 2 and through paired t-test it was significantly noted that Urban-Lowland School 2 had the highest percentage scores with regards to the twelve (12) contents: (1) Introduction to Disaster Concepts, (2) Concepts of Exposure and Vulnerability (3)Identifying Exposed elements (4) Introduction to different types of Hazards (5) Potential Earthquake hazards 1 (6)Tsunami Signs (7)Potential Earthquake hazards 2 (8) Earthquake Hazard Maps (9) Precautionary and Safety Measures for Earthquakes (10)Different Types of Volcanic Hazards (11) Volcano hazard Maps and (12) Precautionary and safety Measures for Volcanic Eruption with corresponding learning competencies.

The level critical thinking skills of senior high school students in Rural and Urban schools had a general percentage of 31.81 which indicated a low mastery level in all the content or topics and with a p-value of 0.00 which means that there was a significant difference among the school at alpha level 0.05. Using the Tukey test, it was found out that there were significant differences among the schools in urban and rural schools particularly in rural-coastal school to urban-coastal school, rural-coastal

school to urban-lowland school 1, rural-coastal school to urban-lowland school 2, rural-upland school 1 to urban-coastal school, rural-upland school 1 to urban-lowland school 1, rural-upland school 1 to urban-lowland school 2, rural-upland school 2 to urban-coastal school, rural-upland school 2 to urban-lowland schools. It was significantly noted that the urban schools had higher percentage scores than rural schools.

2.In terms of the notable experiences of the students, the raising of interest, awareness and mostly the positive behavior among students with regards to the DRRR Concepts were significantly noted, specifically: (1) The students' understanding from rural-coastal school were enhanced through asking questions regarding the key concepts connected to the lessons and appeared to understand the lesson resulting them to become aware with the concepts presented on the lessons and collaboratively work together to solve specific problems that was associated to the lessons, (2) Students rural-upland school 1 were also observed as engaged throughout the lessons and appeared to understand the concepts presented. It was also shown the students acted with honesty, transparency and responsibility towards the lessons and reviewed their own opinions and beliefs. (3) The students from rural-upland school 2 appeared to rely on their own thinking and gained interest on the lessons being discussed by the teacher (4) The students from urban-coastal school related the concept of DRRR into real life situations and shared the knowledge gained based from the discussions in DRRR class. They solved problems by sharing information to their classmates. They performed different classroom activities which increased their participation to classroom lessons. (5) The students from the urban-lowland school 1 became more aware with DRRR concepts and created new set of ideas based from the lessons through creative thinking; and (6) Students from urban-lowland school 2 planned, acted and responded to the lessons with an eye to the future and become more active into classroom discussion.

3.The level of content knowledge of the students after the lesson in the content knowledge test was 84.15 which shows that the students already had near full mastery level of the content. To test the significant difference of this percentage gain, an alpha of 0.05 was used, lower p value than alpha means that the performance had significant difference while higher p value than alpha indicates no significant difference. The p value computed from pretest and posttest is 0.00. This implied that there was a significant difference between the pretest and posttest or the location of the schools which showed that the students' mastery level in content knowledge raised from low mastery level to near full mastery level but it was significantly noted also that there was no significant difference among the interaction of pre and posttest and the locations of the schools. Using the Tukey test, it was found out that rural-coastal school was significantly different to the urban-lowland Schools wherein it was noted using the paired t-test that the urban -lowland schools gained higher average percentage scores compared to other schools while the rural schools gained the lowest average percentage scores after the lessons but all the rural and urban schools had significant increases on the level of content knowledge after the conduct of the lessons.

The level of critical thinking skills after the lesson showed that the students already had near to mastery level of the critical thinking skills. To test the significant difference of this percentage gain, an alpha of 0.05 was used, the p value computed

from pretest and posttest is 0.00. This implied that there was a significant difference between the pretest and posttest or the location of the schools which showed that the students' mastery level in content knowledge raised from low mastery level to near full mastery level. Using the Tukey test, it was found out that all the rural schools had significant differences among all the urban schools. Using the paired t-test, it was noted that the urban schools gained higher average percentage scores compared to rural schools but all of the schools had significant increases in the level of critical thinking skills after the lesson.

4.The values and attitudes developed after the lessons of the students among the schools were the students gained awareness towards the importance of DRRR concepts and they do not think only about themselves but the students showed empathy to other people, manifested determination in doing appropriate precautionary measures when a disaster strikes, showed positive attitude such as determined, became responsible and prepared citizens in facing disasters. They loved also to have knowledge with regards to DRRR concepts. Students became hopeful and confident to apply their learned DRRR concepts into real life situations.

Based on the findings, the following conclusions were made:

1.The level of content knowledge among the students in DRRR before the lessons from rural schools and urban coastal school were in low mastery level but urban lowland schools were already in near mastery level and it was significantly noted that the urban lowland 2 school had the highest average percentage score among the schools. For the level of critical thinking skills before the conduct of the lessons that all the rural and urban schools were in low mastery level and it was significantly noted that the urban lowland 2 school had the highest average percentage score among the schools.

2.Students developed sense of awareness with regards to the DRRR concepts which can be associated based from the student's experiences.

3.The level of content knowledge and critical thinking skills of the students after the lesson from rural and upland schools gained significant increases wherein all the schools were already in the mastery level except with the urban-lowland 1 school with near full mastery level and urban-lowland 2 school with full mastery level.

4.Positive values and attitudes were developed after the conduct of the lessons

Based on the conclusions, the following recommendations were made:

1. Seminars, workshops and trainings, related to DRRR may be proposed to help the students enhance their level of content knowledge and critical thinking skills.

2. Teachers may incorporate technology with active learning approach to further improve the level of content knowledge and critical thinking of students in DRRR.

3.Further studies may be conducted to increase the level of content knowledge among the students from the rural schools, improve their critical thinking skills and values and attitudes towards DRRR concepts.

4. Similar study may be conducted to determine if the level of content knowledge and critical thinking skills of the students will affect their performance in the different field of Science and other subjects.

5. Teachers may develop lessons and interventions with active learning approach to further improve effective learning behaviors towards learning DRRR Concepts.

References

Abuso (2015). Disaster in the time of K to 12: Embedding t'he disaster preparedness in the K to 12 curriculum. Xavier University. Ateneo de Cagayan.

Adams (2002). Constructivist teaching in science. Asia-pacific forum on science learning and teaching. Vol. 3, Issue 1, Article 1.

Ariola J. (2011). Development and validation of lessons on ecological and environmental concepts in Biological Science. (Unpublished Master's thesis, Bicol University)

Asaad, A. S. & Hailaya W.M. (2004). Measurement and evaluation: Concept and principles. Malabon, Metro Manila: Keruso Publishing House

Briones C. B (2017). Teachers' competency on the use of ICT in teaching Physics in the junior high school. (Unpublished Master's Thesis, Bicol University Graduate School)

Buera F. (2012). Guided inquiry laboratory in Physics: Conceptual understanding, higher order thinking skills, science process skills and attitude of students. (Unpublished Masters' Thesis, Bicol University)

De Leon M. (2016). Disaster readiness and risk reduction. Cubao 1109, Quezon City; Trinitas Publishing, Inc.

DepEd Memorandum No. 160, s. 2012. Deped- national education testing and research center: Mastery level descriptive equivalence.

Dorosan A. (1995). The efficacy of an inquiry-oriented learning environment on enhancing the performance of high school Physics. (Unpublished Doctoral Dissertation, De La Salle University)

Enero L.M. et. al (2018). Disaster readiness and risk reduction students' academic achievement in a web-based learning platform. (Unpublished Masters Thesis, Ateneo De Manila University)

Good, Carter V. and Scates, Douglas B. (1972).Methods of Research. Philippines Copyright, Appleton-Century-Grofts. Inc. 1972, Pp 615-616.

Guiterrez, D. S. (2007) Assessment of learning outcomes. Malabon, Metro Manila: Keruso Publishing House.

Hussain et. al (2011). The effectiveness of scientific attitude toward Physics teaching through inquiry-method versus traditional teaching lecture method of female students at secondary school level in Pakistan. Interdisciplinary Journal of Contemporary Research in Business. Vol.3, No. 4. August 2011. Institute of Interdisciplinary Business Research.

Magnusson S, et.al.(1999). Nature, sources, and development of pedagogical content knowledge for Science teaching. In: Geiss-Newsome J., Lederman N.G. (eds) Examining Pedagogical Content Knowledge. Science & Technology Education Library, Vol 6. Springer, Dordrecht.

Maguire et.al (2000). The development of values, attitudes and personal qualities. The Mere, Upton Park, Slough, Berkshire; National Foundation for Educational Research.

Mayor J. (2015). Learning resource material for grade 7 Science integrating ecological solid waste management concepts. (Unpublished Master's thesis, Bicol University)

Padmanabhan (1994). Determining students' attitude towards Physics through problem-solving strategy. Asia-Pacific Forum on Science Learning and Teaching. Volume 10, Issue 2, Article 1.

Peñaflor (2007).Effectiveness of environmental education- enriched lessons in Biology in enhancing students conceptual understanding, thinking skills and attitudes. (Unpublished Masters' Thesis, Bicol University).

Oliva D.G. (2016). Disaster readiness and risk reduction. Makati City, Philippines; Diwa Learning System Inc.,

Republic Act No. 10121. Congress of the Philippines.

Republic Act No. 9512. Congress of   the Philippines.

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