DEVELOPMENT OF A FRAMEWORK AND A MODEL ON DISASTER RISK REDUCTION FOR SCIENCE TEACHER PROFESSIONAL DEVELOPMENT IN BILIRAN PROVINCE, THE PHILIPPINES

IAN PHIL CANLAS

UNIVERSITI SAINS MALAYSIA

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by

IAN PHIL CANLAS

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LIST OF ABBREVIATIONS

DRR	Disaster risk reduction
DRRE	Disaster risk reduction education
TPD	Teacher professional development
DRRM	Disaster risk reduction and management
RA	Republic Act
DepEd	Department of Education
CHED	Commission on Higher Education
TESDA	Technical Education and Skills Development Authority
DOST	Department of Science and Technology
PAGASA	Philippine Atmospheric, Geophysical, and Astronomical Services Administration
PHIVOLCS	Philippine Institute of Volcanology and Seismology
NEAP	National Educators Academy of the Philippines
NDRRMC	National Disaster Risk Reduction and Management Council
DND	Department of National Defense
UN	United Nations
UN-GA	United Nations – General Assembly
UNDRR	United Nations Office for Disaster Risk Reduction
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
ADPC	Asian Disaster Preparedness Center
ASEAN	Association of Southeast Asian Nations
CAPRADE	Comité Andino para la Prevención y Atención de Desastres

CDEMA	Caribbean Disaster Emergency Management Agency
CEPREDENAC	Centro de Coordinación para la Prevención de los Desastres en América Central
OAS	Organization of American States
SAARC	South Asian Association for Regional Cooperation
TPACK	Technological, pedagogical, and content knowledge
TPCK	Technological pedagogical content knowledge
CK	Content knowledge
PK	Pedagogical knowledge
TK	Technological knowledge
PCK	Pedagogical content knowledge
TCK	Technological content knowledge
TPK	Technological pedagogical content knowledge
VBN	Values-Beliefs-Norms
AV	Altruistic values
BV	Biospheric values
EV	Egoistic values
OC	Openness to change
WI	Willingness to initiate
WF	Willingness to face
ACG	Awareness of general consequences
ACR	Awareness of role-related consequences
AR	Ascription to responsibility
PN	Personal norms
SN	Social norms

SNG	General social norms
SNR	Role-specific social norms
EFA	Exploratory factor analysis
PLS-SEM	Partial least squares structural equation modeling
VIF	Variance inflation factor
HTMT	Heterotrait-monotrait ratio
AVE	Average variance extracted
I-CVI	Index-content validity index
S-CVI/AVE	Scale-content validity index/average
S-CVI/UA	Scale-content validity index/universal agreement
E-CVI	Element-content validity index
C-CVI/AVE	Component-content validity index/average
C-CVI/UA	Component-content validity index/universal agreement

LIST OF APPENDICES

PEMBANGUNAN KERANGKA DAN MODEL PENGURANGAN RISIKO BENCANA UNTUK PEMBANGUNAN PROFESIONAL GURU SAINS DI WILAYAH, FILIPINA

ABSTRAK

Peningkatan bilangan, intensiti dan ketidakpastian bencana alam di seluruh dunia telah menyebabkan peningkatan kesedaran untuk mengintegrasikan pengurangan risiko bencana dalam kurikulum di sekolah terutamanya kurikulum sains bagi program pendidikan asas di Filipina. Memandangkan pengurangan risiko bencana adalah suatu isu semasa yang membimbangkan, pengintegrasian pengurangan risiko bencana dalam kurikulum sekolah menyediakan beberapa peluang dan juga beberapa cabaran kepada bidang pendidikan khasnya terhadap sekolah-sekolah awam. Kajian multifasa ini adalah bertujuan bagi merekabentuk sebuah model pembangunan profesional pengurangan risiko bencana bagi para guru sains di sekolah-sekolah awam di Wilayah Biliran, Filipina. Kajian 1 dalam kajian multifasa ini bertujuan meninjau pelaksanaan pengintegrasian pengurangan risiko bencana dalam pengajaran subjek sains di sekolah-sekolah dalam kalangan pelajar-pelajar gred 3 hingga gred 10 melalui analisis dokumen dan temubual pihak-pihak yang berkepentingan. Pihak-pihak yang berkepentingan terdiri daripada penyelaras pengurangan risiko bencana, pengetua-pengetua sekolah, para guru sains dan para pelajar yang dipilih melalui kaedah pensampelan teoretikal berpandukan teori asas ("*Grounded theory*").

Dapatan daripada kajian 1 digunakan bagi membimbing kajian 2 yang bertujuan mengukur pengaruh pengetahuan teknologi, pengetahuan pedagogi, pengetahuan kandungan, nilai, kepercayaan dan norma terhadap pengajaran pengurangan risiko bencana dalam kalangan 189 orang guru sains yang dipilih melalui kaedah

pensampelan kluster. Dapatan kajian 2 bersama garis panduan sedia ada daripada Jabatan Pendidikan telah digunakan bagi membimbing pelaksanaan kajian 3 yang bertujuan merekabentuk model pengurangan risiko bencana yang beracuankan konteks tempatan bagi pembangunan profesional para guru sains. Pembangunan profesional pengurangan risiko bencana tersebut dibangunkan menerusi proses Delphi yang dilaksanakan oleh sepuluh orang pakar yang telah dipilih secara spesifik. Analisis kandungan dan tematik dokumen-dokumen utama kurikulum pengurangan risiko bencana dan kurikulum sains program pendidikan asas Filipina menunjukkan wujudnya peluang bagi mengintegrasikan pengurangan risiko bencana dalam kurikulum sains. Manakala, dapatan temubual menunjukkan kekurangan garis panduan spesifik dan prosedur yang bersesuaian dengan konteks tempatan untuk diintegrasikan secara sistematik dalam kurikulum pengurangan risiko bencana bagi kegunaan pembangunan profesional para guru sains. Akibat daripada kekurangan ini pelaksanaan pengajaran pengurangan risiko bencana bergantung kepada prerogatif para guru sains. Lanjutan daripada ini, pengaruh pengetahuan teknologi, pengetahuan pedagogi, pengetahuan kandungan, nilai, kepercayaan dan norma terhadap pengajaran pengurangan risiko bencana dalam kalangan para guru sains diukur dan dianalisa dengan menggunakan pendekatan Pemodelan Persamaan Kuasa Dua Terkecil Separa Berstruktur (PLS-SEM). Dapatan menunjukkan ketiga-tiga jenis pengetahuan, mempunyai pengaruh signifikan positif terhadap pengajaran pengurangan risiko bencana. Nilai, kepercayaan dan norma para guru sains dalam melaksanakan pengajaran pengurangan risiko bencana juga dilaporkan mempunyai pengaruh signifikan yang positif bersesuaian dengan teori Nilai-Kepercayaan-Norma (VBN). Akhirnya, dapatan kajian ini telah membawa kepada pembentukan sebuah model pengurangan risiko bencana yang telah disahkan melalui proses Delphi bagi

digunakan dalam pembangunan profesional para guru sains dengan menggunakan 4A (*anchor, add, apply, away*).

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ABSTRACT

The increasing number, intensity, and unpredictability of natural hazards all over the world has increased the call and consensus to integrate disaster risk reduction in existing school curricula such as the science curriculum of the Philippine basic education programme. Considering that disaster risk reduction is an emerging concern, it brings a number of opportunities and challenges in the education sector including public schools. This multiphase study was aimed at developing a model of a science teacher professional development on disaster risk reduction for public school teachers in Biliran Province, the Philippines. Study 1 attempted to explore the implementation of disaster risk reduction in schools specifically the integration and teaching of disaster risk reduction in science from grades 3 to 10 through document analysis of key curriculum documents and interviews of key stakeholders including the disaster risk reduction coordinator, school principals, science teachers, and students whose selection was guided by the theoretical sampling principles of the Grounded theory. Informed by the results of Study 1, Study 2 attempted to measure the influence of technological, pedagogical, and content knowledge, as well as values, beliefs, and norms on teaching disaster risk reduction from among 189 science teachers selected through cluster sampling. Results of Study 2 together with existing guidelines from the Department of Education informed Study 3 that attempted to develop a contextualized model of a science teacher professional development on disaster risk reduction through Delphi process participated by ten purposively selected experts.

Content and thematic analysis of key disaster risk reduction curriculum documents and the science curriculum of the Philippine basic education programme revealed opportunities for disaster risk reduction in the science curriculum while interviews revealed the lacking contextualized and localized teacher professional development and the lacking specific guidelines and procedure for systematic integration of disaster risk reduction in science, therefore its frequent inclusion and emphasis in teaching is left to the prerogative of the teachers. Related thereto, the influence of technological, pedagogical, and content knowledge, as well as values, beliefs, and norms on teaching disaster risk reduction from among science teachers was probed and measured and analysed through partial least squares-structural equation modeling. Results revealed the positive significant influence of technological, pedagogical, and content knowledge on teaching disaster risk reduction and the influence of values, beliefs, and norms on teaching disaster risk reduction conformed to the Value-Belief-Norm Theory of environmentalism. Finally, a model on science teacher professional development on disaster risk reduction was developed using the 4As (anchor, add, apply, away) of the dialogue learning approach validated through the Delphi process.

CHAPTER 1

INTRODUCTION

1.1 Introduction

The increasing number, unpredictability, and intensity of disasters all over the world in the last 50 years has increased the call for an immediate and proactive Disaster Risk Reduction (DRR). Considering the nature of natural hazards and the accompanying threats they posed, experience and research has proven that one of the most effective ways of addressing disasters is through a multisectoral approach, that is different sectors of the society that are directly and indirectly associated with DRR are actively involved in all its phases (de Guzman, 2003; Olu et al., 2016; UNISDR & UNDP, 2012).

The most recent international treaty and agreement on DRR at least in the United Nations (UN), the Sendai Framework for Natural Disaster Risk Reduction: 2015-2030 *(often referred to as the Sendai Framework)*, recognizes the important role of the education sector towards public awareness and information dissemination of DRR (UN-GA, 2015). One of the Disaster Risk Reduction Education (DRRE) strategies widely reported is the teaching of DRR at all levels in schools. Selby and Kagawa (2012) provided the initial baseline information on the inclusion of DRR in the school curricula of 30 countries including the Philippines. Their study has revealed that many countries integrates DRR in existing school subjects such as physical and health education, geography and science (Selby & Kagawa, 2012). Therefore, it may be inferred that science education may play a vital role in DRR. As of writing, the science curriculum of the Philippine basic education programme in fact includes in its content standards themes on natural hazards such as typhoon, earthquake, and volcanism.

The increasing call and consensus among experts on DRR to integrate DRR in existing school curricula may result to a number of implications. One, would be the preparedness and readiness of the teachers to teach the added component. That being so, it is necessary to enhance their existing knowledge and skills and develop new ones that are pre-requisite to successfully carrying out the new components or add-ons to the curriculum such as the integration and teaching of DRR in science. The nature of DRR fits the advocacy of Aikenhead (Aikenhead, 2003, 2006; Lee et al., 2012) on locally-relevant science curriculum. In that, it is relevant and practical to develop a context-specific and locally-relevant Teacher Professional Development (TPD) on DRR to support science teachers. This is particularly important considering the differential vulnerability experienced by the different islands of the Philippines such as Biliran Province, one of the smallest island provinces that is exposed to elevated threats to climatic-meteorological and geo-seismic hazards brought by the island's geographical location, topography, and geologic composition.

Along this line, as an initial step in understanding the different tenets of teaching DRR, it is necessary to explore the knowledge-base of science teachers, as well as the correlates of their behavior such as values, beliefs, and norms in the context of teaching DRR, as this is imperative in developing a model on science TPD on DRR. This knowledge-base includes the technological, pedagogical, and content knowledge, while among the correlates of a pro-environmental behavior reported extensively in literature include values, beliefs and norms.

Having considered the above-mentioned, this study explored the teaching of DRR in science of the basic education programme among public schools in Biliran Province, the Philippines to develop a model of a science TPD on DRR.

1.2 Background

1.2.1 Disaster Risk Reduction Education

The turn of the twenty-first century is marked with an emerging trend on the active promotion of DRR to all sectors of the society including the education sector (Tran, 2009). The role of education in DRR was first stipulated at least in the UN during the declaration of the International Decade for Natural Disaster Reduction that commenced in year 1990 (UN-GA, 1989). This was reinforced with the passing and approval of the Yokohama Strategy and Plan of Action for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation *(often referred to as the Yokohama Strategy)* during the First World Conference on Natural Disaster Reduction in year 1994 (UN-GA, 1991, 1994b). Be that as it may, it was only during the Second World Conference on Disaster Reduction in year 2005 with the creation and endorsement of the Hyogo Framework for Action that the role of education gained an increased attention (UN-GA, 2002, 2006). Today, the Sendai Framework, created and endorsed during the Third World Conference on Disaster Risk Reduction in year 2015, explicitly defined the role of the education sector in DRR, that is the effective, efficient, inclusive, and proactive public awareness and information dissemination of DRR (UN-GA, 2013, 2015). In this study, DRRE refers to the formal teaching and learning of DRR in schools, hence would encompass the important pillars and tenets of teaching and learning process including curriculum and content, teaching pedagogy and instructional materials, and students' assessment in the context of DRR, as well as teachers' and education leaders' perspectives of DRR teaching and learning.

1.2.2 Disaster Risk Reduction and Disaster Risk Reduction Education in the Philippines

The Philippines is an independent archipelagic state in the west Pacific. Considering its geographic location and structure, the country is one of the most vulnerable places to meteorological-climatic and geo-seismic hazards (Université catholique de Louvain, 2019). In 2010, the Philippines passed Republic Act (RA) 10121, also known as the Philippine Disaster Risk Reduction and Management Act of 2010, a national legislation that created the organizational structure, strategies and logistical arrangements for DRR. The education sector as represented by the Department of Education (DepEd), Commission on Higher Education (CHED), and Technical Education and Skills Development Authority (TESDA) is included in the governing body of the National Disaster Risk Reduction and Management Council (NDRRMC) that is under the Department of National Defense (DND). NDRRMC is responsible in developing of and ensuring synergy in all efforts related to DRR in the country (Republic of the Philippines, 2009).

In response to RA 10121, the DepEd passed the Comprehensive Disaster Risk Reduction and Management in Basic Education Framework through DepEd Order No. 37, series 2015 (DepEd, 2015d). The said framework institutionalized DRR in all offices and basic education institutions *(elementary and high schools)* across the country. It served as the basis for all DRR efforts in the basic education sector. The third pillar of the framework is on DRR in education which emphasizes the integration of DRR in the school curricula and extracurricular activities (DepEd, 2015d). Although, prior to the enactment of this framework or even the passing of RA 10121, there had been DRR-related efforts in the education sector as initiated by the DepEd (DepEd, 1973, 1990c, 1995d, 2006, 2007).

1.2.3 Biliran Province

Biliran Province is one of the smallest island provinces in the Philippines located in the Eastern Visayas Region (Region 8) *(refer to the map in Chapter 3)*. The island faces the western Pacific coast hence it experiences an elevated level of threat to climatic-meteorological hazards such as storms and typhoons during the western Pacific typhoon season from June-December of each year. Moreover, the island has one of the active volcanoes in the Philippines, the Mt. Biliran, hence it experiences local seismic activities every now and then. Further, the geologic composition of the island makes it vulnerable to flashfloods, landslides, and mudflows during heavy rains and storms among others (Center for Environmental Geomatics - Manila Observatory, 2005; Lapidez et al., 2015).

1.2.4 Teaching and Learning of Disaster Risk Reduction

The teaching and learning of DRR is among the strategies for DRRE identified and implemented across various disaster-vulnerable regions and countries including the Philippines (ASEAN, 2013; Pama, 2015; Selby & Kagawa, 2012). Based on the available documentations of the DepEd reviewed, the role of schools in DRR has been recognized in the basic education sector in the Philippines from the 1970s (DepEd, 1973).

Despite the increasing consensus and agreement of bringing DRR into formal teaching in the classroom, there is a scarcity of study in almost all its dimensions. This include the ways and strategies it is being integrated and taught, the effectiveness and efficiency of these strategies, the existing and evolving gaps and issues, and perhaps most importantly, how formal education may result to successful DRR if indeed it does. However, despite this gap in literature, there is rich research in education and science education in particular that revealed and articulated that significant level of

awareness (Abdellah, 2015) and knowledge (Xu et al., 2013), positive belief (Ren & Bai, 2016), as well as positive attitude (Xu et al., 2013) and values (Tarabashkina & Lietz, 2011; Wigfield & Cambria, 2010) results to higher achievement and better performance. One may hypothesize that the same is true in the context of learning DRR.

Mainstreaming DRR in schools through its formal inclusion in the basic education programme such as its inclusion in the science curriculum may significantly contribute in the public awareness and information dissemination of DRR. As such, it may reduce expenditures related to awareness programs and information dissemination drives initiated by the different government and non-government organizations across levels that are repetitive and incoherent.

There are evidences of DRR-specific themes in the science curriculum and vice versa (ADPC, 2007; Batton et al., 2015; DepEd, 2008, 2016c, 2017c, 2017d; Kagawa & Selby, 2014; Selby & Kagawa, 2012). Perhaps this is the reason of claiming the integration of DRR in the science curriculum as reported by Selby and Kagawa (2012) and as contained in the reported accomplishment of the Hyogo Framework for Action of the different regional organizations (ASEAN, 2013; CAPRADE, 2013; CDEMA, 2011; CEPREDENAC, 2011; OAS, 2009; Pacific Applied Geosciences Commission, 2013; SAARC, 2013) and countries such as the Philippines (Pama, 2015).

Having DRR integrated as evidenced by the above-mentioned reports and documentations was not enough to adjudge the success of DRRE at least along this line. It is necessary to move one step forward, that is bringing to forefront the teaching of DRR into research. Considering that DRRE is an emerging field in education, as a start, it was necessary to explore the existing and evolving gaps and issues in bringing DRR to formal teaching in the classroom, as well as to explore how DRR fits into the

existing frameworks and theories in education. This knowledge and understanding allowed the creation of further steps to ensure that the teaching of DRR is effective, efficient, and inclusive in addressing the call for public awareness and information dissemination on DRR.

1.2.5 Disaster Risk Reduction and Science Education

There are bits and pieces that connects DRR with science education. The works of Selby and Kagawa (2012) on the integration of DRR into existing school curricula of 30 countries including the Philippines has identified that science is among the subjects whereby DRR is integrated. Preliminary review and comparison of the DRR curriculum materials and the science curriculum of the Philippine basic education programme published online by the United Nations Office for Disaster Risk Reduction (UNDRR) and DepEd respectively would show that there are DRR-specific themes in science and vice versa (ADPC, 2007; Batton et al., 2015; DepEd, 2008, 2016c, 2017c, 2017d; Kagawa & Selby, 2014; Selby & Kagawa, 2012).

The overarching goal of science education is developing scientific literacy of different forms such as the ones enumerated and elaborated in the visions of scientific literacy (Roberts, 2007; Sjöström & Eilks, 2018) which is reflected in the science curriculum of the Philippines (DepEd, 2016c). One may hypothesize the possible link that connects DRR and the increasing complexity of scientific literacy. This being said, one may infer the nexus between scientific literacy and DRR. Such that, a successful scientific literacy may entail a successful DRR and a failed DRR may be a reflection of a failed scientific literacy.

There are several factors that may be attributed to successful scientific literacy (Altun & Kalkan, 2019; Baroudi & Rodjan Helder, 2019), but one that is considerably

important is the role of the science teacher (Aragão & Marcondes, 2018; Meacham, 2017; Pearson, 1990). Taking into account that bringing proactively DRR in science teaching is new, it was necessary to provide support to science teachers such as conducting a TPD to ensure its success.

1.2.6 Teacher Professional Development

The increasing consensus and agreement of bringing DRR into the classroom through its integration into the curricula of existing subjects such as science may have serious implications to science teachers. Studies have shown that teachers equipped with sufficient knowledge base (Hiebert, Gallimore, & Stigler, 2002; Mishra & Koehler, 2006; Shulman, 1986; Verloop, Van Driel, & Meijer, 2001), possessing positive values, and influenced by positive beliefs and norms tend to perform better in the classroom (Campbell et al., 2004; Heck, 2009; Toropova et al., 2019). Hence DRR, as an added component in the curricula, requires the strengthening of existing and adding of new knowledge and skills that form part of the teachers' knowledge base in teaching DRR, as well as developing and stimulating their motivation and commitment to proactively consider DRR in the different tenets and stages of their teaching practice.

There are a number of doing so, however considering the resources available and the current context and state of science teaching in the basic education programme specifically in the public schools, the most efficient and reasonable way to address the issue timely is through an implementation of a carefully designed context-specific and locally-relevant TPD on DRR for science teachers. There are evidences of TPDs on DRR initiated and conducted by the DepEd and other organizations who actively advocate for DRR at different levels, however these TPDs were generic and there is a deficit of evidence as to their respective effectiveness and efficiency.

1.2.7 Knowledge Base in Teaching

The knowledge base of teachers may have been first emphasized and brought to limelight by Shulman (1987,1986) along with his pedagogical and content knowledge. He pointed out and explained the importance of pedagogical and content knowledge towards successful teaching and learning. This was later advanced and expanded by Mishra and Koehler (2006) taking into account the increasing role of technology in education, hence coming up of the technological, pedagogical, and content knowledge (TPACK) framework. The framework outlines and provides the foundations as to how content knowledge, pedagogical knowledge, technological knowledge and their respective interrelationships results to effective, successful, and meaningful learning (Mishra & Koehler, 2006).

Along this line, considering that proactively bringing DRR in science teaching is new, like the other specific themes in science whose link to TPACK framework is already well established in literature (Root-Bernstein et al., 2014; Sheffield et al., 2015), it was relevant to explore how DRR fitted in the TPACK framework. Studies have shown that knowing the initial state of teachers' knowledge base in teaching using the TPACK framework was useful in guiding and informing the development of a TPD that is content-specific, context-specific, and issue-specific among others (Chai, 2019; Doyle & Reading, 2012; Hong & Stonier, 2015; Jaipal-Jamani & Figg, 2015; Kafyulilo & Fisser, 2019; Morsink et al., 2011). Therefore, in this study, understanding science teachers' TPACK in teaching DRR was an important pre-requisite in developing the model of a science TPD on DRR.

1.2.8 Values, Beliefs, Norms, and Pro-environmental Behavior

Similarly, both studies in psychology and education have established the different influences of a specific behavior such as teaching and their respective interrelationships (Clinton et al., 2018; Goldberg, 2003; Hattie, 2003; Zuber & Altrichter, 2018). Among those that have been the subject of this kind of study specifically on behaviors relating to the environment includes values, beliefs, and norms (Ghazali, Nguyen, Mutum, & Yap, 2019; Steg, Bolderdijk, Keizer, & Perlaviciute, 2014; Steg & Vlek, 2009; Stern, 2000; Stern, Diets, Abel, Guagnano, & Kalof, 1999). Considering that most existing grey literature and research places DRR in environmental science and environmental education, it may be reasonable to commence with examining the behavioral attributes in teaching DRR such as values, beliefs, and norms.

Studies have shown that developing a TPD that are specific to developing and or strengthening positive values, beliefs, and norms were helpful in increasing commitment towards teaching practice and achieving the desired teaching performance (de Vries et al., 2014; Fischer & Hänze, 2019; Lieberman, 2009; Msila, 2014; Tal & Yinon, 2009; Teng, 2016) among others. Hence, gaining an insight on science teachers' values, beliefs, and norms on teaching DRR was useful in developing the specific components of the TPD model on DRR for science teachers.

1.3 Problem Statement

DRRE is an emerging field in education. There seems to be a consensus on the integration of DRR into existing school curricula (ASEAN, 2013; Pama, 2015; Selby & Kagawa, 2012). In the Philippines, there are evidences that DRR has been taken into

consideration in the basic education sector as early as 1970s (DepEd, 1973), In fact, there are reports that presented on different recommended and existing activities, programs, and projects in relation to DRRE, however there is a deficit in literature on studies that explore the existing and evolving gaps and issues in the teaching of DRR specifically in science and in Biliran Province (*Disaster Education*, 2007; Selby & Kagawa, 2012; Tran, 2009). This is confirmed by the preliminary scooping interviews conducted by the researcher to selected stakeholders.

With the increasing consensus and agreement on bring DRR into the classroom through formal teaching such as teaching in science, there is a need to provide support to science teachers along this line considering that DRR is generally an added component in the science curriculum. A TPD on DRR for science teachers will help strengthen existing and develop new knowledge and skills required for the integration and teaching of DRR. There are evidences of TPD on DRR being developed and implemented in the public schools, however these TPDs were found to be *generic*, that is one training design, usually developed and implemented by the DepEd and other organizations that strongly advocates for DRR (DepEd-Eastern Visayas, 2018; Selby & Kagawa, 2012; UNICEF, 2009; UNICEF & UNESCO, 2012). None of the literature reviewed, as well as preliminary scooping interviews revealed any existing information on the effectiveness and efficiency of these TPDs (Selby & Kagawa, 2012). There is no TPD that is locally-, contextually-, and subject-specific such as a TPD on DRR intended for science teachers. Therefore, there is a need to develop a research-based, localized, contextualized, and subject-specific TPD on DRR considering the differential vulnerability experienced by the different regions, countries, and islands in the Philippines, as well as the nature of the subject DRR is integrated and taught.

The first initial step in developing a localized and contextualized TPD on DRR for science teachers is understanding their knowledge base on DRR. There are studies that explored the technological, pedagogical, and content knowledge of science teachers on themes related to environmental science such as climate change (Abdullah et al., 2011; Chapoo et al., 2014; Mthethwa-Kunene et al., 2015; Ng, 2018; Seroussi et al., 2019; Voogt et al., 2016). Literature reviewed showed that most studies pertaining to DRRE were still on the surface and has not reached yet a deeper level and specificity such as those relating to science teachers technological, pedagogical, and content knowledge on DRR (Selby & Kagawa, 2012; Tran, 2009). Being able to support and enhance science teachers' knowledge base in teaching DRR may boost the frequent inclusion and the teaching of DRR in science.

Similarly, studies related to general behavioral influences to teaching are well established in research along with factors that affects or influences pro-environmental behavior, such as the influence of values, beliefs, and norms (Begum, 2012; Haney et al., 2007; Ko & Lee, 2003; Trendell Nation, 2017; Zachariou et al., 2017). However, like the former, studies reported in literature has not reached yet a deeper level and specificity such as those relating to behavioral influences towards teaching DRR (Selby & Kagawa, 2012; Tran, 2009). Being able to positively support and strengthen the behavioral influences on the integration and teaching of DRR may result the frequent integration and teaching of DRR in science as well. Both the former and the later gaps identified from literature were at the same time confirmed by the preliminary scooping interviews with key stakeholders conducted by the researcher.

Considering the above-mentioned premise, this study intended to investigate the integration and teaching of DRR in science, science teachers' knowledge base in teaching DRR, as well as behavioral influences related thereto. Collective findings of

which informed in developing a model on science TPD on DRR for Biliran Province, the Philippines. The same may be adopted by other islands of similar context.

1.4 Research objectives

This entire research is divided into three studies; Study 1, 2, and 3 respectively. Study 1 explored the implementation of DRR in schools specifically the integration and teaching of DRR in science while Study 2 measured the influence of technological, pedagogical, and content knowledge, as well as values, beliefs, and norms on teaching DRR. Finally, Study 3 developed a contextualized model of science TPD on DRR using Delphi approach and informed by the results of Study 1 and 2. Research objective 1 directed Study 1, while research objectives 2 to 7 directed Study 2. Lastly, research objective 8 directed Study 3.

1. To explore the implementation of DRR at schools specifically:
    a. Determine the science-specific themes from key DRR curriculum documents
    b. Determine the DRR-specific themes from the science curriculum of the Philippine basic education programme
    c. Explore the integration of DRR in teaching science
2. To measure the influence of technological, pedagogical, and content knowledge on the teaching of DRR.
3. To measure the influence of values on the teaching of DRR.
4. To measure the influence of beliefs on the teaching of DRR
5. To measure the influence of norms on the teaching of DRR
6. To measure the influence of values on beliefs in the teaching DRR.

7. To measure the influence of beliefs on norms in the teaching DRR.
8. To develop a contextualized model on science TPD on DRR using Delphi approach and informed by the influence of technological, pedagogical, and content knowledge, as well as values, beliefs, and norms on teaching DRR.

1.5 Research questions

Similarly, Study 1 attempted to answer research question 1 while Study 2 attempted to answer questions 2 to 7. Finally, Study 3 attempted to answer research question 8.

1. How is DRR implemented in schools?
    a. What are the science-specific themes from the key DRR curriculum documents?
    b. What are the DRR-specific themes from the science curriculum of the Philippine basic education programme?
    c. How is DRR integrated in teaching science?
2. What is the influence of technological, pedagogical, and content knowledge on teaching DRR?
3. Is there a significant influence of values on teaching DRR?
4. Is there a significant influence of beliefs on teaching DRR?
5. Is there a significant influence of norms on teaching DRR?
6. Is there a significant influence of values on beliefs in teaching DRR?
7. Is there a significant influence of beliefs on norms in teaching DRR?

8. How the Delphi process informs the development of a model on science TPD on DRR informed by the influence of technological, pedagogical, and content knowledge, as well as values, beliefs, and norms on teaching DRR?

1.6 Hypotheses

The following were the hypotheses that study 2 aimed to test and find:

1. There is a significant positive influence of technological, pedagogical, and content knowledge on teaching DRR.
2. There is a significant positive influence of values on teaching DRR.
3. There is a significant positive influence of beliefs on teaching DRR.
4. There is a significant positive influence of norms on teaching DRR.
5. There is a significant positive influence of values on beliefs in teaching DRR.
6. There is a significant positive influence of beliefs on norms in teaching DRR.

1.7 Rationale

There are several ontological and epistemological reasons and foundations for conducting this study as follows.

One of the strategies for DRRE reported by significant number of regional organizations and countries including the Philippines is the teaching of DRR in the classroom (ASEAN, 2013; Pama, 2015; Selby & Kagawa, 2012). Teaching itself has numerous tenets, however, considering that DRRE is an emerging field in education, one may begin with exploring the existing issues and gaps in bringing DRR in the classroom. Such as the case of teaching DRR in science in the basic education

programme. These may be possible by conducting interviews within the hierarchy of the DepEd including the learners.

Secondly, one of the most important factors that determines the success of the teaching and learning process is the teacher. Considering that DRRE is an emerging field, it may be necessary to require teachers to undergo a TPD on DRR. Literature has revealed that there were efforts on conducting TPD related thereto, however, these were generic training programs mandated by the national office of the DepEd or trainings initiated by other related organizations that strongly advocates for DRR (DepEd-Division of Biliran, 2018, 2019; DepEd-Eastern Visayas, 2017, 2018; Selby & Kagawa, 2012; UNICEF, 2009; UNICEF & UNESCO, 2012). Moreover, there is a deficit of literature that determines the success of these training programs. Considering the differential vulnerability experienced by the different regions, countries and islands in the Philippines in particular, one rich ground for research may be development, implementation and assessment of a TPD on DRR. One may begin with developing of a framework derived from the knowledge-base in teaching DRR, as well as values, beliefs, and norms in teaching DRR that will inform in developing a model of TPD on DRR for science teachers that is anchored on existing adult learning theories.

Lastly, although integration of DRR into school curricula is not something new, another rich ground for research that has not been completely explored is on how the teaching of DRR fits into the existing education theories and frameworks. One may commence with exploring the frameworks and theories on the factors that relate to teachers such as the TPACK framework (Mishra & Koehler, 2006) and Value-Belief-Norm Theory (Stern et al., 1999) in the context of teaching DRR.

Moving on, along the selection of locale, the increasing number, intensity and unpredictability of natural hazards, coupled with differential vulnerability it brings to

different regions, countries and islands in the Philippines makes DRR more complicated than one can ever imagine. Efforts related to DRR needs to be contextualized and localized. Along this line, Biliran Province is one of the smallest island provinces in the central eastern portion part of the Philippines. The island province is exposed to almost all types of climate-meteorological and geo-seismic hazards that poses threat to the country all year round, hence the need for extra level of efforts in all sectors including the basic education sector at all levels to cope with the effects of disasters.

Finally, on the selection of theories, education is one of the ancient fields that has ever existed and through millennia of studies, several theories and frameworks have been derived to establish and understand the different pillars, aspects, principles, and tenets of education among others. Considering that DRR is an emerging field in education, another rich ground for research is to explore how the teaching and learning of DRR fits into the existing theories and frameworks in teaching.

Literature showed that science is one of the subjects whereby DRR is integrated. In that it may be worth reflecting how DRR links with the Visions of scientific literacy (Roberts, 2007; Sjöström & Eilks, 2018). The increasing complexity of Visions 1, 2 and 3 of scientific literacy may have some implications with DRR and vice versa.

Having said earlier that, teachers are among the most important factors that determines the success of the teaching and learning process, it may be worth exploring the knowledge-base and behavior of teachers that are related to teaching DRR. Considering that pedagogical and content knowledge is one of the frameworks that outlines the knowledge-base of teachers in the modern times (Mishra & Koehler, 2006; Shulman, 1987, 1986), one may begin with exploring how DRR fits into the TPACK

framework. Similarly, Value-Belief-Norm Theory has been exhaustively explored to explain behavior in the context of education for sustainable development and environmental education. Considering that DRR is included in the scope of education for sustainable development and environmental education, exploring how the teaching of DRR fits into the Value-Belief-Norm Theory may be relevant and worthwhile.

Exploring how DRR fits into these theories in teaching was relevant in developing a science TPD on DRR informed by dialogue learning approach (Norris, 2003) which is anchored on andragogic learning theory (Knowles et al., 2005) using the Delphi process (Green, 2014).

1.8 Significance of the Study

This section presents the methodical, theoretical, and practical significance of the study.

1.8.1 Methodical Significance

This study illustrated an exemplar of a multi-phase mixed methods design on DRRE that any researcher may adopt or refer when conducting a study of similar context or nature. Study 1 provided an exemplar as to how document analysis and interviews involving various level in an existing educational hierarchy explored the implementation of DRR in schools specifically the opportunities for DRR in the science curriculum, as well as the integration and teaching of DRR in science. Study 2 demonstrated how the use of partial least square structural equation modeling (PLS-SEM) determined the influence of technological, pedagogical and content knowledge, as well as values, beliefs, and norms in the integration and teaching of DRR. Lastly, Study 3, demonstrated how the findings in Study 2 informed the development of a

model on science TPD on DRR anchored on andragogic learning theory and using a modified Delphi process.

1.8.2 Theoretical significance

This study was built from four theories namely, visions of scientific literacy (Roberts, 2007; Sjöström & Eilks, 2018), TPACK framework (Mishra & Koehler, 2006; Shulman, 1986), the Value-Belief-Norm Theory of Environmentalism (Stern et al., 1999), and andragogic learning theory (Knowles et al., 2005). As such it reflected on the link of DRR and scientific literacy and explored how the integration and teaching of DRR fitted to TPACK framework and Value-Belief-Norm Theory. The development of the model on science TPD on DRR was anchored on the andragogic learning theory. The process by which the theories were blended in the context of this study may be a useful exemplar for researchers who are and will be doing mixed methods research whereby *mixing* occurs in the theoretical level.

1.8.3 Practical significance

This study provided a baseline information on the implementation of DRR in schools specifically the integration and teaching of DRR in science from among public schools in Biliran Province, the Philippines of which may by useful reference for policy makers and the DepEd specifically. The framework that considered the influence of technological, pedagogical, and content knowledge, as well as values, beliefs, and norms in the integration and teaching of DRR was useful in developing a contextualized science TPD on DRR that may be implemented in the study context as other schools and institutions of similar context. Therefore, may be directly useful for schools and teachers. Indirectly, it may create ripple and benefit the students in the

long run when teachers become equipped with the required knowledge-base and skills on teaching DRR.

1.9 Operational Definition of Terms

This section presents the operational definition of terms.

1.9.1 Disaster Risk Reduction

UN defined Disaster Risk Reduction (DRR) as

> "*… aimed at preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and therefore to the achievement of sustainable development. DRR is the policy objective of disaster risk management, and its goals and objectives are defined in DRR strategies and plans* (UN-GA, 2016)".

In the Philippine context especially to areas or islands that are more vulnerable to natural hazards such as Biliran Province, these are enumeration of all efforts, course and plan of action that are related to DRR from the national level to the local level with multi-sectoral involvement as mandated by RA 10121 including the education sector (Republic of the Philippines, 2009). In the DepEd, DRR is referred to interchangeably with disaster risk reduction and management (DRRM) *(e.g. instead of teaching DRR, they refer it as teaching DRRM)*.

1.9.2 Disaster Risk Reduction Education

Derived from the role of the education sector as perceived in the SFDRR, Disaster Risk Reduction Education (DRRE) maybe defined as *"the call for sustained global public education and awareness along DRR, increased investments in the*

resilience of the education systems and educational facilities, reducing the exposure and new risk for educational facilities, the critical need to increase public education and awareness in post disaster recovery and rehabilitation (UN-GA, 2015)*"*. In the context of this study, DRRE is referred to as the teaching and learning of DRR in the science classroom including the bringing of DRR in the most important facets of teaching and learning such as the integration of DRR in the curriculum and content, DRR-informed pedagogy and instructional material use, DRR-relevant student assessment and TPD on DRR.

1.9.3 Science Education and DRR

Science education and DRR refers to achieving DRR, that is addressing the call for effective, efficient, proactive and inclusive public awareness and information dissemination of DRR, through developing scientific literacy. Scientific literacy may be defined as "*the knowledge and understanding of science concepts and processes required for personal decision-making, civic and cultural affairs, as well as economic productivity* (National Research Council, 2013)*"*. In the context of this study, scientific literacy is referred to as learning the content that directly and indirectly relates to DRR, and applying the same knowledge and understanding throughout the entire cycle of DRR.

1.9.4 Teacher Professional Development

Teacher professional development (TPD) refers to a training program designed for in-service science teachers to develop new, strengthen and enhance the existing knowledge base, increase commitment, and boost the performance of teachers toward their teaching practice. In this study, TPD on DRR for science teachers refers to a training program on DRR for in-service science teachers whose activities are carefully

designed using the Kirkpatrick model, taking into account the result of the assessment on science teachers' knowledge base, as well as their respective values, beliefs, and norms in the context of teaching DRR.

1.9.5 Technological Pedagogical and Content Knowledge

Mishra and Koehler (2006) defined Technological Pedagogical and Content Knowledge (TPACK) as

"*… an understanding of the representation of concepts using technologies, pedagogical techniques that use technologies in constructive ways to teach content, knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face, knowledge of students' prior knowledge and theories of epistemology, and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones* (Mishra & Koehler, 2006, pp.1028-1029)*".*

In the context of teaching DRR, technological pedagogical content knowledge refers to knowing the use of ICT tool for sharing ideas and thinking together, planning for students' own learning, problem solving in groups and other group work, as well as critical, reflective, and creative thinking all in the context of teaching and learning DRR.

1.9.5(a) Technological Knowledge

Technological Knowledge (TK) refers to the ability of the teacher to use effectively and efficiently the standard and advanced ICT tools in the classroom including new emerging technologies *(e.g. desktop, laptop, projector, programs and simulations, Internet, others)* (Mishra & Koehler, 2006). In the context of teaching DRR, technological knowledge refers to familiarity and being able to use new ICT,

websites about new technologies, communication tools *(e.g., WhatsApp, Viber, Skype, FB messenger, online chat, others)*, social media *(e.g., Facebook, Instagram, Twitter, others)*, and web-based collaboration tools *(e.g., Google Docs, Dropbox, others)*. It also refers to being able to solve ICT related problems *(e.g., diagnosing disconnection issues between computer and projector, poor Internet connectivity, others.)*.

1.9.5(b) Pedagogical Knowledge

Pedagogical Knowledge (PK) refers to the teachers' basic knowledge of the different pedagogies including classroom management, selection and use of instructional materials, classroom communication and climate (Morine-Dershimer & Kent, 1999; Shulman, 1986). In the context of teaching DRR, pedagogical knowledge refers to being able to guide students' content-related problem solving in groups, to make use of each other's thoughts and ideas in group work, and plan for their own learning, as well as guide students for critical, reflective and creative thinking.

1.9.5 (c) Content Knowledge

Content Knowledge (CK) refers to teachers' knowledge and understanding of the subject matter (Shulman, 1986). In the context of teaching DRR, content knowledge refers to the sufficiency of knowledge on DRR, including basic theories, concepts, history and development of important theories and familiarity with recent research on DRR. Moreover, it also refers to the understanding of DRR in the local context, as well as familiarity of the Comprehensive Disaster Risk Reduction and Management in Basic Education Framework and the Philippine Disaster Reduction and Management Act of 2010. Lastly, it also refers to the familiarity of the role of teaching in DRR.

1.9.5(d) Technological Pedagogical Knowledge

Technological Pedagogical Knowledge (TPK) is referred to as the teachers' understanding of the general application of ICT in teaching and learning including the selection and utilization of appropriate ICT tools and their respective combination that are relevant to the pedagogy (Harris et al., 2009). In the context of teaching DRR, technological pedagogical knowledge refers to knowing the use of ICT in teaching as a tool for students' planning their own learning, sharing ideas and thinking together, problem solving in groups, as well as the use of ICT in teaching as a tool for students' critical, reflective, and creative thinking.

1.9.5(e) Technological Content Knowledge

Technological Content Knowledge (TCK) is referred to as the teachers' understanding of the general application of ICT in the subject matter. This is the ability of the teacher to select and use the most appropriate ICT tools available to enhance the representation of the subject matter (Harris et al., 2009; Mishra & Koehler, 2006). In the context of teaching DRR, technological content knowledge refers to knowing websites with online materials, ICT-applications used by professionals and teachers, and technologies used to illustrate contents in DRR.

1.9.5(f) Pedagogical Content Knowledge

Pedagogical Content Knowledge (PCK) is defined as the interconnection of pedagogy and subject matter whereby the teacher has the ability to select and use the most appropriate pedagogy in reference to the subject matter (Shulman, 1986). In the context of teaching DRR, pedagogical content knowledge refers to being able to guide students' content-related problem solving in groups, to make use of each other's