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Defining teachers' professional development needs - A study of implementing Marine  
Educator Training Course in Taiwan

Master's Thesis in Education

FACULTY OF EDUCATION

Master's Degree Program in Education and Globalisation

2021



University of Oulu

Faculty of Education

Defining teachers' professional development needs - A study of implementing Marine Educator Training Course in Taiwan (Hung-Chun Liu)

Master's thesis in Education, 93 pages, 4 appendixes

May 2021

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This thesis focuses on understanding teachers' professional development needs after attending the Marine Educators Training Course in Taiwan from teachers' perspectives. Taiwan started to implement Marine Education in 2008 after the White Paper on Marine Education Policy was released by the Ministry of Education, R.O.C. Teachers at all school levels were expected to integrate and teach marine-related topics in various fields of the 12-year basic education. Therefore, Taiwan Marine Education Center (TMEC) conducted an official Marine Educator Training Course to enhance teachers' marine knowledge and teaching skills since 2017 to solve the dilemmas of implementing Marine Education discovered by the Ministry of Education, R.O.C.

The conceptual frameworks of the thesis consist of teachers' Marine Science Content Knowledge, Technological Pedagogical Content Knowledge (TPACK), teacher professional needs, Ocean Literacy (OL), and inspiration from UNESCO and SDGs. For this study, all the conceptual concepts are discussed under teacher professional development as the main fundamental concept. To clarify the conceptual framework of teachers' needs for Marine Education in Taiwan, these five concepts were considered and related in implementing Marine Education for teachers.

This is a qualitative research study involving an analysis of 51 responders among 173 participants of the Marine Educator Training Course from 2017 to 2019 in Taiwan. This study focused on understanding the teachers' professional development needs that are still required for implementing Marine Education in the classroom after attending this training course. This study aimed to analyze the teachers' answers to this specific open question was collected by an e-questionnaire. The methodology of this study used Qualitative Content Analysis (QCA).

This study indicated that teachers in different school levels have different demand levels, and these demands could be divided into three areas. First, for elementary and junior high school teachers, they are the majority groups needing the support of Marine Educational TPACK compared to the other two groups. Second, the possible potential for the sixth principle of Ocean Literacy. Because the teacher lacks official textbooks and teaching materials in Marine Education. Third, the importance of school internal support. This internal support helps teachers to reduce their stressed and inexperienced feelings when implementing Marine

Education. Simultaneously, teachers feel valued and acknowledged by the support from peers and administrations within schools. This study aims to bring insight from teachers' perspectives and point out what the teachers' professional development needs should have for marine education teachers in Taiwan. The observations of this study could be a potential example of Education for Sustainable Development for teacher training in basic education.

Keywords: Teachers' professional development needs, Marine Education, Marine Educator Training Course in Taiwan, Teachers' Marine Science Content Knowledge, Technological Pedagogical Content Knowledge (TPACK), Teacher professional needs, Ocean Literacy (OL).

## **Acknowledgment**

I appreciate I finally finished this thesis with great supports from an awesome group of advisors. First, I would like to thank the director of Taiwan Marine Education Center, Cheng-Chieh Chang. Without his support, I can't start this research. When I asked him about the possibility of conducting this research as my master thesis for the first time, he agreed with my idea and gave me this permission to conduct this research. Because of his permission, I can collect data easily in this study. Second, I would like to thank my two supervisors. First to Anne Pellikka for being willing to listen and discuss my research ideas and ambitions. She has even shown her interest and willingness to be my supervisor in the first place. Throughout the supervising period, she trusted me and kindness to give me her suggestions based on her own personal experience. Second to Audrey Paradis for accepting my invitation when I was looking for her help with qualitative content analysis. She provided me many amazing details and thoughtful suggestions from a qualitative perspective. Because I have a Marine Science background in Taiwan, it is not easy for me to view things through a qualitative lens. These amazing details help me to know how to deal with my data through a proper QCA process and also allow me to revise my thesis in a more coherent conceptual framework. Especially thanks to Juan Rivera Ramirez and Bárbara Barrionuevo Bonini are willing to be my peer reviewer. Both of them helped me revise my wording, grammar and also used examples to help me go through my confusions. And finally, thank you to anyone who finds and reads this thesis. I hope it would be helpful for you and could bring some insights for your study and research.

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# **1. Introduction**

## **1.1 The origin of Taiwan Marine Education**

Even though Taiwan is an island, people in the past were not allowed to enjoy, touch, and understand the sea around it because of the Martial Law. Taiwan Martial law was a specific period in the history of Taiwan after World War II. It lasted over 38 years between May 20, 1949, and July 14, 1987, under the control of the Republic of China's Armed Forces led by the Kuomintang Government of the Republic of China regime (Ministry of Education, R.O.C., 2017, p. 3). Before lifting the Martial Law ban in 1987, the ocean and the coast became part of the National Defense and were strictly controlled. This impacted the state of mind and culture of Taiwanese who lived on the island who seemed to fear the ocean, little less mention marine anything about development. Besides, due to the influence of Sinicization thought, a phenomenon that presents Taiwan and China as a whole, Taiwan was still considered part of mainland China. This resulted in the content of education focusing more on land rather than on the ocean.

Taiwan is located at an important marine hub with rich marine resources. Therefore, Taiwan should be regarded as a marine country and committed especially to global or regional development, protection, alliances, and cooperation. Therefore, we are prioritizing the sustainable development of Taiwan's waters when promoting marine education. At the same time, it is still necessary to increase citizens' understanding of the world. Ministry of Education, R.O.C. (2017) stated that "... should increase the international ocean perspective, cultivate global citizens with ocean awareness and knowledge, and do a good job in integrating with the international is the basic work of the marine society" (Ministry of Education, R.O.C., 2017, p.24).

In marine society, the ocean is the common resource of humankind. Hence, marine environmental protection and rational development, and resource utilization are the core

values and issues (Ministry of Education, R.O.C., 2017, pp. 15-18). Therefore, as a country surrounded by the sea; apart from encouraging citizens to participate in the construction of a high-quality marine society, marine education policies also need to develop citizens' awareness such as having marine cognition and mindset of marine citizens to be able to protect and make good use of the ocean. Every citizen needs to have the basic abilities and a level of quality ocean understanding, making good utilization, and caring for the ocean under more professional arrangements (Ministry of Education, R.O.C., 2017, pp. 3-4). Consequently, this research focuses on the development of crucial marine education for Taiwanese people, based on recent developments in training Marine Educators.

## **1.2 Background of Marine Education**

Basic education at all school levels seldom appears to foster marine literacy for citizens, which has kept the ocean out of peoples' attentions and thoughts (Ministry of Education, R.O.C., 2017, p.3). This phenomenon causes a lack of marine education in addressing citizens' marine awareness, the guidance in education policies, talents, and an industrial gap. Although Taiwan lifted martial law in 1987, the intangible limitations of long-term ideology and psychological habits have influenced the establishment of the cultural mindset that coexists with the ocean. Despite its rarity in basic education, marine education has always been used in specific and related subjects such as maritime affairs, fisheries, and aquaculture in higher vocational colleges and universities, so the definition of marine education is usually regarded as a specific field within education.

*Ocean White Paper* (Research, Development and Evaluation Commission, Executive Yuan, 2001), an official report which was investigated by hired Taiwan Marine Science researchers from the government, analyzes the current problems in the relevant areas of ocean affairs and develops policy goals. In this official document, marine affairs are divided into maritime safety, sustainable marine resource management, education, and culture. At the same

time, this report proposed four visions and three goals are for Taiwan's marine policy (Research, Development and Evaluation Commission, Executive Yuan, 2001, p.6). Before the *Ocean White Paper* was released in 2001, there was a lack of discussions on promoting marine education in basic education from primary and secondary schools (Wu, 2010, p.27). However, in the same year, the government focused on promoting Taiwan's marine education in different policies such as *The National Ocean Policy Program* in 2004, the *Ocean Policy White Paper* in 2006, and the *White Paper on Marine Education Policy* in 2007, which created the platform for Taiwan's marine education policies, development goals, and strategies (Sheu, 2011, p.62). The *White Paper on Marine Education Policy* (Ministry of Education, R.O.C., 2017, p.22) states that marine education includes general education for fostering marine citizenship, technologies of maritime work, marine-related industries, and professional education.

Marine General Education is to foster student's basic marine literacy, and it covers school education extending from elementary school to university, social education provided by social and environmental educational institutions, and family education as well. Its goal is to foster grass-roots level and professionals in the marine industry. On the other hand, Marine Professional Education refers to the education conducted by the marine time-related departments and departments set up by secondary schools and above (United Nations Educational, Scientific and Cultural Organization, 1988, pp.3-4; Ministry of Education, R.O.C., 2007, p.21).

Due to the influence of the Martial Law period and the Sinicization thought, there have been few marine-related teaching materials in Taiwanese education. Most educational and administrative agencies lack special funds for oceans and personnel with backgrounds in marine-related expertise. Moreover, schools do not have sufficient funds to promote hardware and software facilities for marine education. This has led marine education to be undervalued on all levels of Taiwanese education. This was observed by Ministry of Education, R.O.C.

which states that even though schools have the responsibility of fostering national marine literacy, they still have not incorporated marine education in their curriculums (Ministry of Education, R.O.C., 2017, pp. 15-18; Sheu, 2011, p.62).

According to Lwo (2008, p.115), the analysis of relevant research reports pointed out that before 2001, the content of marine education was less than 3% of the overall content in the national primary school textbooks and less than 5% of the overall content in the national secondary school textbooks. Moreover, in the teaching materials, the concept of marine education is not emphasized enough within earth science and biology courses teaching materials, and marine culture and aesthetics are missing from the Arts' and Social Humanities' materials. Nevertheless, after the Ministry of Education, R.O.C. incorporated marine education into the *Grade 1-9 Curriculum Guidelines Major Issues (Marine Education)* in 2008, the marine education courses gradually began to be implemented in schools at all levels. To continue deepening the *Grade 1-9 Curriculum Guidelines Major Issues (Marine Education)*, the *Curriculum Guidelines of 12 Year Basic Education* was released in 2014. The Ministry of Education, R.O.C. also required that school's curriculum design should be properly integrated into marine education issues. This meant that schools should plan based on the revised curriculum if necessary (Wu, 2010, pp.27-28).

Therefore, to further strengthen marine education and integrate the holistic concept that could integrate systematic thinking and promote sustainable development, Ministry of Education, R.O.C. (2017, p.26) constructed the following key strategies for marine education development based on the three major strategic axes. These strategies were meant to strengthen marine education's promotion mechanism, improve the citizens' marine literacy, and enhance the knowledge of marine professionals. There are 6 key strategies related to the 12-year basic education as follows (Ministry of Education, R.O.C., 2017, pp.26-27):

- (1) Improve the marine education promotion system of educational administrative agents at all levels,

- (2) Strengthen the integration and communication platform to promote marine education,
- (3) Promote the sharing, exchange, and utilization of marine education-related resources and information,
- (4) The integration of marine education into textbooks in various fields of the 12-year basic education,
- (5) Strengthen courses and teaching related to marine education at all levels of schools,
- (6) Cooperate with the 12-year basic education to conduct marine career trial education, and establish a mechanism for further education and employment consultant.

To implement and integrate Taiwan's marine education, resources should be consistently developed and available. In response, the Taiwan Marine Education Center (TMEC) was established in 2013. The purpose is to help the Ministry of Education, R.O.C. to promote local marine education by integrating national marine education resources; reviewing and planning marine education policies. Since 2013, TMEC, the local marine education center, and school teachers have carried out continuous cooperation. The local marine education centers are set up by the local governments which are assisted by the Ministry of Education, R.O.C. since 2008 (Ministry of Education, R.O.C., 2007, p.9). The local center's main function is to grasp the development status and problems encountered in Taiwan's marine education and provide counseling and consultation on marine education and the long-term integration of marine education-related achievements and resources (Ministry of Education, R.O.C., 2017, p.13).

Several issues have been identified since the Marine Education implementation in 2008 by TMEC research funded by Ministry of Education, R.O.C. (Ministry of Education, R.O.C., 2017, p.13). All issues could be categorized into 4 dilemmas for Marine Education in Taiwan. First, there is no integrated system for marine educators; second, the working conditions vary significantly between marine educators leading to differences in teaching quality and lack of consistency, partly because the Ministry of Education, R.O.C. has not set up a central marine education counseling team; third, the human resources of local marine education centers lack

systematic integration and; fourth, marine education is a new field for many basic education teachers. Therefore, TMEC further developed and proposed the training mechanism for Marine Educators hoping to build a professional culture for marine education and provide common competencies to improve the quality of marine educators, and develop marine educator facilitators in schools to build a sustainable mechanism for marine education (Taiwan Marine Education Center, 2020a).

To solve these dilemmas, TMEC designed a Marine Educator Training Plan. Marine educators' purpose is to foster citizens' marine literacy and upgrade the quality and consistency of implementing marine education in 12-years basic education (Ministry of Education, R.O.C., 2017, p.4). There are three levels within this Marine Educator Training Plan. Only two levels of Marine Educator Training Courses have been implemented until now (Figure 1). The first, the green level, aims at attracting more people to engage in marine education, enhance their interest and passion for marine services and expand their considerations for marine education at their positions. The second, blue level, in turn, is to attract their interest for marine services and expand their marine consideration in promoting marine education to grow further and to engage more people in marine education (Taiwan Marine Education Center, 2020a). These two implementations have been conducted to help Taiwan's teachers and educators improve their professional knowledge of marine education around Taiwan, such as the North, Middle, South, and East region of Taiwan, once at least from 2017.

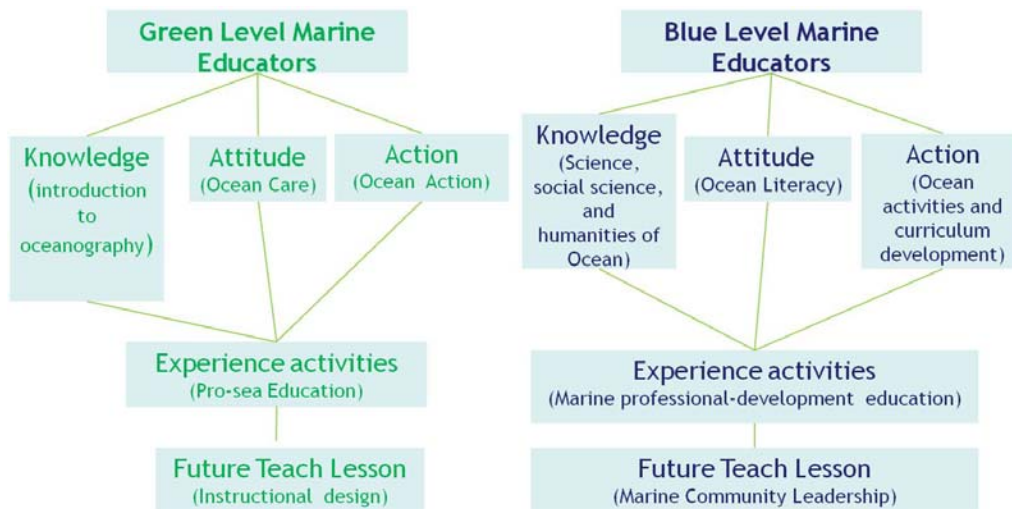


Figure 1. The structure of the levels of Marine Educator Training courses designed by TMEC (Taiwan Marine Education Center, 2020b but modified by author).

### 1.3 The current situation with Marine education

In *the Grade 1-9 Curriculum Guidelines Major Issues (Marine Education)*, the purpose is that primary and secondary schools should create an educational environment of “approaching, loving and knowing ocean.” In this version, the logical syllabus framework for marine education topics is 1 concept, 3 goals, 5 themes, 16 subcategories, and 116 ability indicators (Ministry of Education, R.O.C., 2008, pp.1-2; 10-11; Lwo, 2018, p.8; Cheng & Wang, 2019, p.141). Lwo (2018, p.9) designed the diagram to explain the Marine Education Framework Outline of 12 Year Basic Education (Figure 2). Within this Framework outline, one basic concept is Taiwan as a nation by sea. Three goals are approaching, loving, and knowing the ocean.





Figure 2. The Marine Education Framework Outline of 12 Year Basic Education (Lwo, 2018, p.8 but modified by author).

Nine Literacies could be fostered in Marine education, such as:

- (1) Establish the philosophy of life to explore the meaning of life, and keep improving,
- (2) Think, analyze, take actions and deal with the problems of marine ecology and environment,
- (3) Plan and execute marine activities to increase the appropriate interaction between man and the sea,
- (4) Use language, mathematics, physical and artistic in expressing and communicating to enhance interaction with the ocean,
- (5) Speculate and criticism ocean issues with information, technology and other media,
- (6) Create ocean-related art and culture to enrich aesthetic experience,
- (7) Actively participate in marine social activities, and care about natural ecology and sustainable development,
- (8) Establish good interpersonal relationships and participate in social service teams with the spirit of tolerance,
- (9) Respect and appreciate multiculturalism, care about global issues and international

situations, and develop a mind for world peace.

The five themes are:

- (1) Marine leisure,
- (2) Marine culture,
- (3) Marine society,
- (4) Marine science and technology, and
- (5) Marine resources and sustainability.

Among these five themes are 16 subcategories, such as a focus on water safety awareness and the relationship between Taiwan's historical development and the ocean, etc., for elementary school; junior high school has 20, such as explore the impact of marine-related industries development on Taiwan's economy and understand the significant relationship of ocean folk beliefs and ceremonies with social development, etc. There are still 20 for upper secondary schools, such as creating literary works with the ocean by using various styles or writing skills properly and understanding global marine environmental issues, participating or being familiar with marine protection actions, etc., with a total number of 56 Elements/Subgroups.

Table 1 illustrates how the five themes in marine education can be integrated into the other subjects in the primary, junior high, and senior high schools. Generally speaking, it looks like it can easily integrate any main curriculum subject into one of the marine themes in Table 1. However, it might be hard for teachers to do so without any proper multidisciplinary teaching guidelines. Besides, marine education is not one of Ministry of Education, R.O.C.'s mandatory (MOE- mandatory) subjects for teachers in Taiwan but is only one of the issues within *Grade 1-9 Curriculum Guidelines Major Issues (Marine Education)*. Rather than the traditional single subject, every marine education arrangement competes with the number of teaching hours in other mandatory subjects. It is impossible to become the main axis of education in schools without a good arrangement.

Table 1. The five themes in marine education can be integrated into the other subjects in the primary, junior high and upper secondary schools (Lwo, 2018, p.9).

<b>Themes</b>	<b>Subjects in Primary schools</b>	<b>Subjects in Junior High schools</b>	<b>Subjects in Upper Secondary Schools</b>
<b>Marine Leisure</b>	<ul style="list-style-type: none"> <li>➤ Health and Physical Education</li> <li>➤ Integrative Activities</li> </ul>	<ul style="list-style-type: none"> <li>➤ Health and Physical Education</li> <li>➤ Integrative Activities</li> <li>➤ Social Studies</li> </ul>	<ul style="list-style-type: none"> <li>➤ Health and Physical Education</li> <li>➤ Integrative Activities</li> <li>➤ Social Studies</li> <li>➤ Arts</li> </ul>
<b>Marine Culture</b>	<ul style="list-style-type: none"> <li>➤ Language Arts</li> <li>➤ Social Studies</li> <li>➤ Arts</li> </ul>	<ul style="list-style-type: none"> <li>➤ Languages Arts</li> <li>➤ Social Studies</li> <li>➤ Arts</li> </ul>	<ul style="list-style-type: none"> <li>➤ Language Arts</li> <li>➤ Social Studies</li> <li>➤ Arts</li> </ul>
<b>Marine Society</b>	<ul style="list-style-type: none"> <li>➤ Social Studies</li> <li>➤ Life Curriculum</li> </ul>	Social Studies	<ul style="list-style-type: none"> <li>➤ Social Studies</li> <li>➤ Technology</li> <li>➤ National Defense Education</li> </ul>
<b>Marine Science and Technology</b>	<ul style="list-style-type: none"> <li>➤ Natural Sciences</li> </ul>	<ul style="list-style-type: none"> <li>➤ Natural Sciences</li> <li>➤ Social Studies</li> <li>➤ Technology</li> </ul>	<ul style="list-style-type: none"> <li>➤ Natural Sciences</li> <li>➤ Social Studies</li> <li>➤ Mathematics</li> </ul>
<b>Marine Resources and Sustainability</b>	<ul style="list-style-type: none"> <li>➤ Natural Sciences</li> <li>➤ Social Studies</li> </ul>	<ul style="list-style-type: none"> <li>➤ Natural Sciences</li> <li>➤ Technology</li> <li>➤ Social Studies</li> </ul>	<ul style="list-style-type: none"> <li>➤ Natural Sciences</li> <li>➤ Social Studies</li> </ul>

#### 1.4 Research questions, aims and the purpose of the research

Due to its cross-disciplinary nature, marine issues are not easy for teachers to integrate into different learning areas and other subjects. This was a common problem when teachers implemented marine education in the classroom (Sheu, 2011, p.80; Cheng & Wang, 2019, pp.141-142). That is why Taiwan's teachers still hesitate to implement marine education in the classroom even though it has been implemented since 2011. Although Taiwan has started to implement the 12 Year Basic Education in 2019, it needs to address this issue seriously.

Teachers are necessary to master its integration more comprehensively and think about its relationship with other education categories.

I take into consideration the historical background of Taiwan and the contemporary situation where the first efforts to educate marine education professionals is prevalent. I also wonder how, in the future, can we improve and provide more comprehensive Marine Educator Training Course for teachers and educators to upgrade the quality and consistency is the key in implementing marine education. Therefore, my research question is focused on **what are teachers' professional development needs after attending this Marine Educator Training Courses in Taiwan?**

### **1.5 Researcher Background**

As a doctor in Marine Biology and an Environmental Education Specialist, I can easily transfer the general concept of Marine Science-related topics in understandable words or examples to fit the audience. However, even as an 8-year experienced Environmental educator in marine professionals' knowledge, I am still not confident about how to integrate my knowledge well when the topic relates to Marine society or other non-familiar themes. Based on my own personal, professional development experience as an educator, it means that I still need to study and expand my professional knowledge of these 5 themes: marine leisure, marine culture, marine society, marine science and technology, and marine resources and sustainability, in Marine Education all the time and asking for support from other experts or related teaching materials. This training course is conducted in 3 days for the green level and in 5 days for the blue levels, separately. From my perspective, this short-term training is still not enough for participants' to have a full understanding of marine profession knowledge and practicing the integrated teaching approaches. Besides, even if I attended a training course; I still can find out and realize what extra professional needs or supports I still needed after the practical experience in teaching. To sum up, that is the main reason why I am interested in this

research topic.

## **2. Conceptual framework**

In this section, I will talk about the conceptual aspects considered in this study. The aim of the section is to clarify the conceptual framework of teachers' needs for Marine education under teacher professional development. First, the concepts of the study will be discussed under teacher professional development as the main fundamental ideology. There are five concepts within my conceptual framework that is used as lenses throughout this section.

Teacher professional development is defined as '[...] the professional growth a teacher achieves as a result of gaining increased experience and examining his or her teaching systematically' (Glatthorn, 1995, as cited in Villegas-Reimers, 2003, p.11). The professional development of teachers is one of the key elements of educational reform for many societies. However, it causes some problematic perspectives just like every coin has two sides. Some people acknowledge teachers as a profession but others might focus to make sure of their adequate teaching standards (Villegas-Reimers, 2003, p.7). Therefore, teachers usually expect it is useful for their teaching after they attended teachers' professional development programs (Villegas-Reimers, 2003, p.7; Shulman, 1986, p.9). In the Science Teacher Professional Development Framework was proposed by Haney and Lumpe (1995, p.192), there was three-phase, (a) planning, (b) training, and (c) follow-up, within this framework. In the follow-up phase, they mentioned that continuous assistance in the classroom should be provided by local staff such as administrators, teacher leaders, community members, and university collaborators, etc. This is an important component because it could embrace teachers to feel continued support from inside of schools. Based on Haney and Lumpe (1995, p.193), they also described needs-based components which were emerging from research, theories, and surveys. The collaboration between these needs-based components into the science education professional development framework not only has a nurturing atmosphere

for the teachers but also reaches an effective outcome.

Examining the development situation in the past ten years, it is obvious that teacher is the key to promoting Marine Education in schools. At the same time, teachers' cognition, enthusiasm, and teaching transformative and practical ability are the decisive factors in implementing Marine Education. However, in Taiwan's past education system, there were no marine education-related courses that were provided in the teacher training process. As a result, teachers, especially primary and junior high school teachers, generally lacked marine-related concepts and lacked marine education-related teaching capabilities (Wu, Wang, Cheng, and Tsai (2018, p.17). Because Marine Education is not one of the mandatory subjects by Ministry of Education in Taiwan yet, Wu et al. (2018, p.20) suggested that Ministry of Education, R.O.C. could improve the current situation in three ways, (1) assist teachers in teacher training institutions to improve marine literacy, (2) construct a Marine Education network learning platform for teachers and trainees, and (3) develop the Marine Education Pilot Courses in Joint Pilot Schools. These recommendations similar to the needs-based components which were mentioned in Haney and Lumpe (1995, p.193), and the last two ways could increase Marine Education resources and people network formally. It helps teachers to form the Marine Education community inside or outside of schools, and this mechanism might allow school leaders and administrators to support teachers implement Marine Education actively.

Sheu (2011, p.63) addressed that there are different terms related to "marine education", including "aquatic education", "water education", "sea education", "ocean education", "maritime education", and "marine education". The meaning of the first two refers to a wide range of marine education, such as water education, water resources education, education of rivers, lakes, rivers, and wetlands (National Oceanic and Atmospheric Administration [NOAA], 1998, as cited in Sheu, 2011, p.63); secondly, "sea education" and "ocean education" are related to education about the sea and the ocean, while "maritime education" is

related to the education of fostering maritime professionals. Finally, "marine education" has more meanings refers to marine general education maritime in junior high schools, primary schools, and even higher education. According to the report of the Ministry of Education, R.O.C. (2007) and the newly revised *Grade 1-9 Curriculum Guidelines*, marine education is officially listed as the seventh major topic. The concept and main axis of the marine mentioned in it are including marine leisure, marine society, marine culture, marine natural sciences, and marine resources. The foregoing content reflects the three major learning categories of marine nature, marine society, and marine humanities, and the educational concept covers educational orientation, goals, categories, curriculum, teaching, and assessment (Sheu, 2011, p.64). Even in the *Guidelines of 12-Years Basic Education Major Issues (Marine Education)* was announced in March 2018, the learning objective of marine education issue still more or less focused on these areas, such as experiencing marine leisure and approaching ocean behaviors, which emphasize the safety of playing with water, the understanding of marine society, having the loving ocean feelings in marine culture, and exploring the literacy of knowing ocean in marine science and sustainable marine resources (CIRN, 2015).

Based on what has been mentioned above, it matches Sheu's (2011) observation. He pointed out marine education has a cross-disciplinary nature (Sheu, 2011, p.80). For this reason, it is not easy for teachers to integrate into different learning areas and other subjects. Because of that, I am going to discuss the following five concepts as my conceptual frameworks that should be included in this study under teacher professional development for Marine Education. Those concepts are Technological Pedagogical Content Knowledge (TPACK), Teachers' Marine Science Content Knowledge, Teacher professional needs, Ocean Literacy (OL), and inspiration from UNESCO and Sustainable Development Goals (SDGs) (Figure 4).

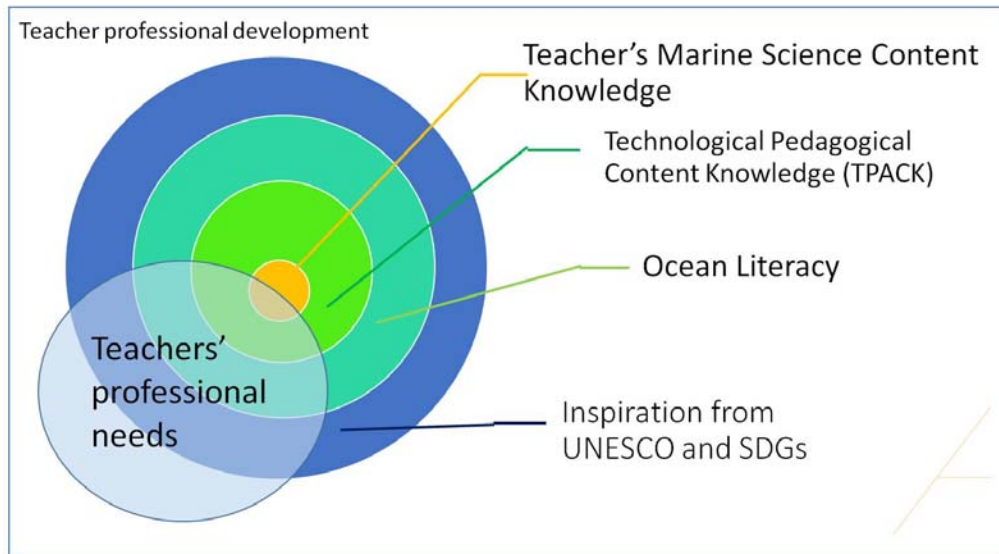


Figure 3. The 5 conceptual frameworks under teacher professional development in this study.

In 1988, the United Nations Educational, Scientific and Cultural Organization (UNESCO) publication, Year 2000 Challenges for marine science training and education worldwide, Marine Education should include the Marine Science Specialist Training, and General Marine Science Education (United Nations Educational, Scientific and Cultural Organization, 1988 pp.3-4). Meanwhile, training also recommended multidisciplinary approaches and access to computers and other electronics (United Nations Educational, Scientific and Cultural Organization, 1988 p.2). Based on the concept mentioned in this publication, Marine Science Content Knowledge should be the core concept relevant to Teachers' TPACK skills. Ocean Literacy (OL) was proposed in 2015 by National Oceanic and Atmosphere Administration (NOAA) and National Marine Educator Association (NMEA), the United States. It included a comprehensive framework of Ocean Science as a holistic picture (Cava, F., Schoedinger, S., Strang, C. & Tuddenham, P., 2005, p.15). This study focuses on the teacher training program in Marine Education. Therefore the relations between this study and 17 Sustainable Development Goals (SDGs) and teachers' professional needs also need to under consideration. I mentioned above all the reasons I choose these five concepts as my conceptual framework for this study.



Among these five concepts, some of them are more relevant to education, and some of them are more related to marine professional knowledge. Some of them are more like the global blueprint. Hence, I am going to discuss these five concepts of my conceptual framework into three groups: (1) Different areas of knowledge of teaching Marine Education, (2) Sustainable development goals and ocean literacy in teaching Marine Education, and (3) Enhancing teachers' professional development in marine education.

## **2.1 Different areas of knowledge for teaching Marine education**

Among these five concepts within my conceptual framework, the Teachers' Marine Science Content Knowledge, Technological Pedagogical Content Knowledge (TPACK), and Teacher professional needs are needed and relevant to consider. Because these different types of knowledge play different roles while teaching Marine Education, and that is the reason why these three concepts are discussed together in this group.

### *2.1.1 Teachers' Marine Science Content Knowledge*

In the USA, the National Science Education Standards (NSES) (National Research Council (NRC), 1996) and the Benchmarks for Science Literacy (Benchmarks) (American Association for the Advancement of Science (AAAS), 1993) use scientific literacy to identify student's learning of science standards and benchmarks throughout their K-12 education (Lambert, 2005, p.531). However, most U.S. students do not complete the traditional science courses to be an adult with scientific literacy. Because there are multiple courses, such as earth science, biology, chemistry, and physics courses within this traditional science course, because of this issue, Lambert (2005, p.531) proposed that integrating science curricula could offer a potential solution. He pointed out that Marine Education could be a perfect subject that includes all the national science standards of the U.S. Therefore, Lambert (2005, p.532) proposed a course model where sciences are integrated (Figure 3). There are three elements within his model which are marine science concepts, society, and technology, separately.

Among these three elements, the marine science concepts included the knowledge of biological-, geological-, physical-, chemical-oceanography and meteorological ocean-atmosphere interactions; society included the knowledge of humans and ocean environment, and technology included the knowledge of marine-related technology that benefits humans. Surprisingly, this model has a similar integrated concept as the five themes integrated within Taiwan Marine Education. His model naturally integrates the traditional sciences well, such as science-, technology-, and society-related knowledge.

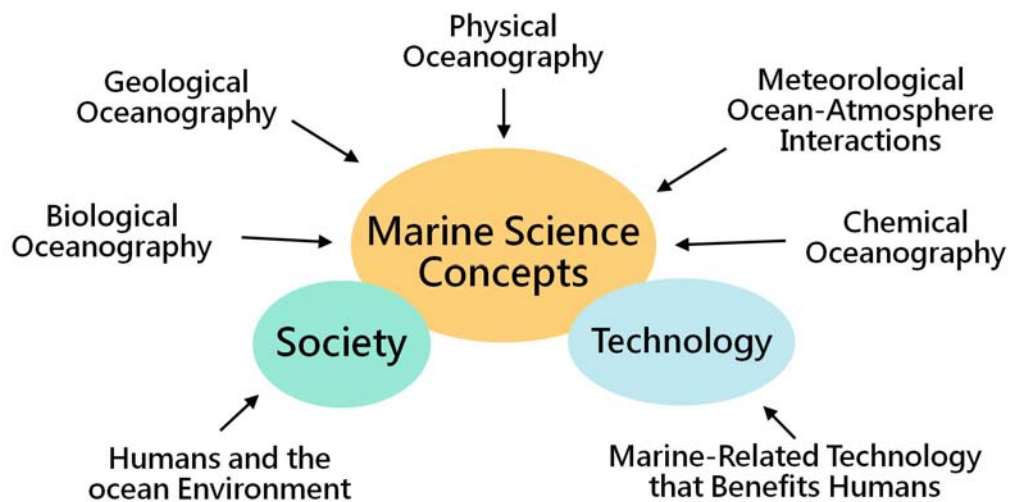


Figure 4. A model for integrating Science, Technology and Society-related National Science Education Standards into Marine Science curricula (Lambert, 2005, p.532).

Simultaneously, Lambert (2005, p.532) also agrees with Hurd's statement (1997), "most of the research in today's science is strategy-oriented and cross-disciplinary; these are the first steps toward a modern science curriculum (as cited in Lambert, 2005, p.532)." According to Lambert's study, marine science can be used as a successful model and a potential reform mechanism for teaching integrated science and a contemporary science discipline.

Besides, various researchers also observed that students in an integrated science course were more completely exposed to science's true nature than in a traditional, single-discipline science course; students can link knowledge between sciences through meaningful learning

experiences (Lopez, 1996, p.269). Also, this integrated science course helps students apply science to their daily lives. Therefore integrated science instruction is an effective teaching method in a connected and context-rich manner (Lambert, 2005, p.532).

However, Lambert (2005, p.538) also pointed out that teachers in this study showed alternative experiences. Although they are high school teachers with an undergraduate degree in the biology-related field, they still mentioned that they conduct the Marine Science I and II of Florida's course s without the specific guidance for planning the course. There was no teaching material such as a formal K-12 Marine Science textbook for teachers to conduct because the available ones are only for the university level. At the same time, he also found out that the difference in teachers' pedagogies also influences students' Science Assessment in Literacy. Therefore, marine science material and teachers' knowledge and integrated ability are key factors in applying US national standards and benchmarks into their marine science curriculum and instruction.

While comparing the Taiwan teachers' situations to what happens in the US in Lambert's study, it is relevant to outline that Lambert's integrating science curricula could provide a means as a potential approach to implement marine education in Taiwan as Teachers' Marine Science Content Knowledge, especially marine education is exactly the integrated science course of his model.

### *2.1.2 Technological Pedagogical Content Knowledge (TPACK)*

TPACK comprises knowledge of content (CK), pedagogy (PK), technology (TK), and along with understanding the complex interaction among these knowledge components. Rittel and Webber (1973, p.166) mentioned that the goal of TPACK is to find the right combination of technologies, teaching approach, and instructional goals when we think about teaching with technology. Besides, Thompson and Mishra (2007, p.38) emphasize that CK, PK, and TK should not be taken in isolation. Rather, they form an integrated whole for helping teachers

take advantage of technology to improve student learning. Hence, Mishra and Koehler (2008, p.2) viewed that TPACK is a way of thinking, and it is about the knowledge for teachers need to understand how to integrate technology effectively in their classrooms. Therefore, TPACK emphasizes in-depth: Teachers integrate technology into their own subject knowledge and use appropriate teaching methods and strategies to evaluate the overall instructional design's operational thinking ability so that the teaching process is more effective, more diverse, and wider with technology.

Before the concept of TPACK emerged, Shulman (1986, p.9) advocates that there was a way of approaching subject knowledge called PCK (Pedagogical Content Knowledge) that involves the teacher's ability to present concepts. Within the PCK approach, all the teaching knowledge of subject concepts allows students to learn about persuasive analogies, illustrations, examples, explanations, and presentations. That is the reason why Hwang, Hong, and Hao (2018, p.448) revealed that teachers value the acquisition of PCK more than PK and CK, separately. PCK helps teachers understand how to make an intersection among sets of content knowledge, learning contexts, and pedagogical knowledge (Nuangchalem, 2020, p.994). Since information and communication technology (ICT) start to develop in 1990s, TK has become one of the important knowledge components of teachers and influences in all professions (Dong, Xu, Chai, & Zhai, 2020, p.147). The TPACK illustrates the important relationship between technology and teaching. Teachers can search for more updated textbooks through the Internet to deepen their knowledge and education. They can also introduce a wide range of novel subject content to students; various technological types of equipment are used to teach and present teaching materials so that students can learn more effectively.

Bustamante (2020, pp.328-329) indicated that professional development is a way for teachers to overcome barriers identified in the literature, such as teachers' knowledge, self-efficacy, beliefs about learning and technology, ease of use, and compatibility with

current practices. Hence, modern teachers with knowledge explosion and rapid technological information need to be able to operate, select, filter, apply these technological types of equipment and combine them with teaching materials and pedagogy. Nuangchalerm (2020) also addressed that “TPACK is now playing its role in the teacher development, teacher preparation program, and teacher professionals (p.993)”. Therefore, if teachers have a good working comprehension of TPACK, it could help teachers obtain more relevant teaching resources and materials of Marine Education and deliver it effectively by various technological devices and equipment.

### *2.1.3 Teacher professional needs*

The experience quality of initial teaching years' for teachers is critically important. It is also a key period of time for them to develop and apply the knowledge and skills during their initial teacher training. Teachers without experience are inflexible, and it is also difficult to improvise or modified suitable lesson plans for students. Various case studies indicated that it is already exhausted and struggling for beginning teachers to design enough curriculum to cope with their immediate needs (Karlberg & Bezzina, 2020, p.2). Since technology became a tool to benefit students learning process, teachers need to adopt emerging technology in pedagogy. In Hofer and Swan's (2008, p.178) study, they explored teachers' knowledge in different fields and its impact on TPACK by arranging middle school students to design documentary teaching activities. In terms of integrating the existing TK, PK, and CK programs, experienced teachers are often more familiar. For example, experienced teachers know how to draw on broad and deep knowledge and an awareness of appropriate pedagogical approaches to inform students by their instruction. It provides an understanding of effective ways to represent the CK of their subjects.

According to what has been mention above, it is a very individual internal process for teachers to integrate their own experiences and knowledge into TPACK. Dong et al. (2020, p.147) tried to explore the potential factors to reduce teachers' technostress from individual's

internal and external factors. Many teachers struggle and lack adequate skills and competencies to use technology for their learning and teaching process. They found out several factors can comprehensively affect their technostress, such as teachers' TPACK level, computer self-efficacy, administration, and collegial support. Among those factors, computer self-efficacy and TPACK have significantly negative effects on their technostress (Dong et al., 2020, p.154). Hofer and Swan (2008, p.181) also revealed that teachers might not necessarily show the same level of TPACK for teaching all topics. For example, a teacher may have deep knowledge of American history, collaborative grouping, and digital imaging but have limited knowledge of structured academic debate and database analyzing. This observation shows that different teachers will have different TPACK performances. These studies suggested that it is essential to enhance teachers' TPACK skills and other external needs such as school and peers' supports.

According to what I have mentioned above, marine education professional development can be tailored to the teachers' needs. Especially, teachers' academic background and school background may have different effects on TPACK (Sheu, 2011, p.62), and their personal background of teachers, the periods of teaching, and the subject impact on TPACK are traceable (Jang & Tsai, 2012 as cited in Lin, 2015, p.92). At present, most of the research on the professional competence of national elementary school teachers focuses on teachers' general teaching professional competence, and the exploration of the professional competence of teachers in individual fields is relatively limited (Sheu, 2011, p.62). In addition to the promotion of marine education in Taiwan and the formulation and support of policy guidelines, teachers' ability to implement marine education is also the key to its implementation. Since teachers' knowledge and application of TPACK varies, it is important to evaluate what teachers gain during training. Therefore, the professional needs could be identified by what is acquired and still needed for teachers in this study.

## **2.2 Sustainable development goals and ocean literacy in teaching Marine education**

Among the five concepts within my conceptual framework, the Ocean Literacy (OL) from UNESCO and Inspiration from UNESCO and SDGs are relevant to the global definition and blueprints mentioned while teaching Marine Education. It provides a historical and global understanding and connects sustainable development Goals under these knowledge backgrounds. Therefore, these two concepts can discuss together in this section.

### *2.2.1 Ocean Literacy (OL) from UNESCO*

In 2002, ocean scientists recognized the lack of ocean-related subjects in formal education and education professionals in the US. They initiated a collaborative and bottom-up process to develop a comprehensive framework to encourage the inclusion of ocean sciences into national and state standards and teach about the ocean in K-12 classrooms. When Science Content and Standards for Ocean Literacy: A Report on Ocean Literacy was published in 2005 in the United States (Cava, et al., 2005, p.15). National Oceanic and Atmospheric Administration (NOAA) and National Marine Educators Association (NMEA) cooperated to release updated versions of Ocean Literacy and related outlines continuously (such as Ocean Literacy-The Essential Principles and Fundamental concepts of Ocean Sciences for Learners of All Ages (NOAA, 2013).

Continuously, National Oceanic and Atmospheric Administration (NOAA) and National Marine Educators Association (NMEA) proposed Ocean Literacy in 2015 by publishing the Science Content and Standards for Ocean Literacy: A Report on Ocean Literacy (Cava, F., Schoedinger, S., Strang, C. & Tuddenham, P., 2005, p.15). This was the start of the Ocean Literacy movement that has spread around the world through the development of marine science educators associations in Canada, Australia, Europe, and Asia. It mainly emphasizes the need to understand the interaction between the ocean and humans. Until now, Ocean Literacy (OL) programs and projects have been focusing on developing resources, lesson

plans, and activities targeting Science, Technology, Engineering, and Mathematics (STEM) education. Therefore, Ocean Literacy is currently the most important reference content for marine education in the United States.

Currently, scientific communities in USA and Taiwan societies have assisted in a shift in the focus towards the inclusion of approaches closer to those developed under the UNESCO framework of Education for Sustainable Development (ESD) after SDGs goals announced (UNESCO, 2017b, pp.15-18; Lin, Wu, Tsai, & Chang, 2020, pp.420-423). In the global, most of the public live our lives unaware of how our day-to-day actions affect the ocean's health and sustainability and its many resources on which we depend. However, marine education is still seldom emphasized in elementary science courses (Barrow, 1992, p.23). Thus, Ocean Literacy (OL) is essential to the understanding of the ocean's influence on us and our influence on the ocean. There are 7 essential principles within it, and principle 6, the ocean and humans are inextricably interconnected, might be highly relevant to Taiwan Marine Education in this study (UNESCO, 2017b, p.19).

Through the seven major principles of Ocean Literacy, it can be seen that the main axis of the US marine education goal is to emphasize the relationship between the ocean itself, the ocean and the land and living things, climate, and humans, and the exploration of the unknown ocean is the key to carry on the past heritage and open up the future. It is very different from the content structure of Taiwan's marine education (Chou, 2015, p.14). The marine education guideline content is mostly duplicated with other existing subjects, and it fails to highlight the uniqueness and importance of marine education. In addition to failing to describe the appropriate marine education curriculum outline, it cannot reveal the unique value of marine education in curriculum development. Simultaneously, the educational purpose of the marine education guideline in Taiwan is not clear enough, and it is difficult to have the overall direction of Marine Education (Hung 2010, p.33; Wu, 2010, p.25; Zhou, 2015, p.9).



As mentioned above, I think only focus on the sixth principle of Ocean Literacy, the ocean and humans are inextricably interconnected, could also be fitted to Taiwan's Marine Education which emphasized three major learning categories in marine nature, marine society, and marine humanities (Sheu, 2011, p.64). However, under this specific principle, Chou (2015, pp.46-47) argued that there have differences between Marine Education in the United States and Taiwan, which were ocean-centered and human-centered. Based on his comparative studies, he indicated that the basic spirit has huge differences between these two even though many items seem to be related. Although there seem to have huge differences between these two, the United Nations Educational, Scientific and Cultural Organization (UNESCO) (2017b, pp.99-101) published Ocean Literacy for all a tool kit in 2017. There are several teaching activities related to Ocean Literacy sixth principle. It could still be a useful teaching material for teachers if they want to implement Marine Education in the classroom.

### *2.2.2 Inspiration from UNESCO and SDGs*

In a UNESCO report (1988), Year 2000 challenges for marine science training and education worldwide, marine science was divided into marine science specialist training and general marine science education. It pointed out that marine science specialist training aims to train marine scientists and engineers as the main goal. Both teachers in the schools and students receiving teacher training also require knowledge in this area. General marine science education aims to help the general public understand the importance of marine resource protection and management. Therefore, we need to introduce and strengthen the implementation of teaching marine education in primary and secondary schools. Simultaneously, students who have not chosen to enter marine-related specialized science education should be provided with non-formal public education to strengthen and continue the promotion of marine education (United Nations Educational, Scientific and Cultural Organization, 1988, pp.3-4).

Science is essential for students in understanding and achieving sustainability nowadays (UNESCO, 2017c, p.38). Also, the Education for Sustainable Development (ESD) is a well-established approach to empower learners to make informed decisions and responsible actions for environmental integrity for present and future generations (UNESCO, 2017a, p.7). In the 2030 Agenda for Sustainable Development, a shared peace and prosperity ideology for people and the planet now and the future was provided, accepted by all United Nations Member States in 2015 (United Nations, 2015, p.3). There are 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership (United Nations Educational, Scientific and Cultural Organization, 2017, p.6). Though Taiwan is not a member country for the United Nations, Taiwan still has the responsibility to develop education to achieve these goals. Therefore, it is important to connect all SDGs in marine education.

This study relates closely to two particular sustainable development goals, one namely the SDG 4: Quality Education and the definition of SDG4 aim to ensure inclusive and equitable quality. The other one is SDG 14: Life below Water in this study. The definition of SDG 14 aims to conserve and sustainably use the oceans, seas, and marine resources for sustainable development (UNESCO, 2017a, pp.18, 38).

As a country surrounded by the sea; every citizen needs to have the basic ability and quality of ocean understanding, making good utilization and caring the ocean under the more professional arrangements. UNESCO (1988) recommended that establishment of national and regional networks among institutions and scientists for cooperation and information exchange was particularly useful in promoting marine science development, and it also needed a system for exchange of marine science information at the national, regional and international level (UNESCO, 1988, p.71). Therefore, the Ministry of Education, R.O.C. actively cooperated to promote the fostering of maritime capabilities in 2001 (Ministry of Education, R.O.C., 2017, p.4). Based on the above, marine education is only the acquisition of marine-related

knowledge and organization, or the arrangement of courses, and hopes to give people the correct values of the ocean, whether it is the use of marine resources and the promotion of marine environment conservation, sustainable development, the coexistence of man and nature to face.

Therefore, this research is more relevant to target 4.7 and target 14.a:

*“ By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and nonviolence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development. ... Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular Small Island developing States and least developed countries.” (UN, 2015, p.19, 26)*

### **2.3 Enhancing teachers’ professional development in marine education**

In the conceptual framework of Marine Education in this study, the Teachers' Marine Science Content Knowledge is the core concept for teachers, and trained teachers should be able to have TPACK to integrate Marine Education in their teaching. In addition, I only focus on the most relevant principle, the sixth, among OL that might be suitable in this study. At the same time, the concept of Marine Education in Taiwan has a relatively small scale compares to the global perspective of UNESCO and SDGs. Besides, it might still have extra teachers’ professional needs, which was not noticed when TMEC designed it, which still needed even though they already attended the training course. Based on this logical inference, under teacher professional development, Figure 4 shows the interaction structure among these five

concepts within my conceptual framework that should be considered in this study.

Hence, it is important to ensure that teachers' ability, which included Marine Science Content Knowledge and TPACK, after the Marine Educator Training Courses to implement marine education in Taiwan. These trained teachers' Marine Education ability is the key to promote and implement marine education in Taiwan. Furthermore, this study has three potential importance of this study: (1) can improve these two level of Marine Educator Training Courses to ensure Taiwan educators' Marine Education relevant skills, (2) could discover what the professional development needs of Taiwan marine education teachers should have, and (3) could be a potential study of education for sustainable development (ESD) about teacher training in basic education.

### **3. Methodological approach**

Since there is a rapid change in the education system worldwide, societies now recognized that teachers' professional development is the most important educational reform element. Teachers become both subjects and objects to improve education systems; therefore, teachers' professional development training programs are growing and are valued nowadays. While attending a teachers' professional development training course, the teachers are usually expected to obtain useful knowledge, strategies, tools, and skills (Villegas-Reimers, 2003, p.7; Shulman, 1986, p.9). Teachers' professional development is a lifelong process that includes teachers' initial preparation, in-service training, and other learning experiences relevant to enhance teachers' practices and professionalism until retirement (Villegas-Reimers, 2003, p.8). This study is a follow-up research of a specific teacher training course, the Marine Educator Training Course in Taiwan. Because Marine Education is not familiar for teachers in Taiwan, it is practical and pragmatic for teachers to apply what they learned immediately after this training course. Therefore, I will investigate what teachers' professional development needs are still required after attending this training course. This study focuses on teachers' perspectives of professional development needs about implementing Marine Education after trained. This qualitative study is conducted through a specific open question in an e-questionnaire. I will analyze teachers' perspectives through their statements, and Qualitative Content Analysis (QCA) is the suitable method for analyzing the collected data.

#### **3.1 Target groups and the data**

For this study, I focused on a specific population based on Marine Education in Taiwan, and I already have specific knowledge of this trained population. The participants were chosen because I am interested to understand the participants' professional needs after attending the Marine Educators Training Courses held by TMEC in Taiwan. This study targets a particular group of teachers in Taiwan, specifically those who attended the Marine Educator

Training Courses held by TMEC from 2017-2019. Based on this reason, I can make sure any participant who is answered my e-questionnaire is matched my specific needs. 173 people attended this course, and all the participants received an e-questionnaire in 2020 because of this study. Of those, only 51 participants answered this questionnaire.

### **3.2 Data collection method**

First, the participants' name lists were obtained from the open sources on the TMEC website in Taiwan (Taiwan Marine Education Center, 2020b). Second, I received permission from the director of the TMEC of Taiwan to conduct this study on the participants. Third, every participant received an invitation letter (Appendix 1) telling them the purpose of this study and asking them to join this study by answering the e-questionnaire within a specific period of time. 172 out of 173 participants received this letter. In qualitative research, purposeful sampling is the most common sampling strategy for the case-related phenomenon of interest in identifying information-rich groups (Palinkas, Horwitz, Green, Wisdom, Duan, & Hoagwood, 2015, p.533). Therefore, the participants were chosen through the purposeful sampling in this study. There were 51 out of 173 participants who answered this e-questionnaire in the study. The invitation letter promised their names to be anonymous and inform the participant that only used their data for this master thesis.

All the data was collected by an e-questionnaire (Appendix 2). This questionnaire included 3 groups of questions. The first group included sociodemographic indicator questions, such as gender, years of teaching, the graduated universities and departments, year and level of training courses, service units and positions, and school categories and locations. In this group, only 2 questions, such as years of teaching, the graduated universities and departments, are open questions, and the rest of the closed questions. The second group with three types of questions which included (1) motivation: the participants' purposes of attending this training course, (2) knowledge: how they feel about the course contents and define

marine education after training, and (3) cognition: the importance of five themes in marine education between teachers' and students' perspectives. Only using the closed question to collect participant's motivations, and the rest of types are all open questions. The third group included questions related to (1) practice: the participants' implementation and challenges after this training course, (2) resources: the participants' professional needs and helps in implementing Marine Education after this training course, and (3) language: the participants' second language ability. In this group, only have 2 yes-no questions and the rest are open questions. Finally, a pilot test was conducted to complete the final version (Bryman, 2012, p.165; Huang & You, 2013, p.424).

As mentioned before, the target groups in this study are Taiwanese participants. Therefore it would be better for them to answer this e-questionnaire in their mother tongue, Chinese. I am a researcher in this study and a Taiwanese, a Chinese-native speaker, and I designed this e-questionnaire in Chinese and allowed the responders to answer in Chinese. The data could lose meaning in the translating process because of its nature of the interpretive act. If it is not the researcher's native language, it also influences the researcher to understand and analyze data. Therefore, Nes, Abma, Jonsson, and Dee (2010, p.315) recommended it can reduce the loss of meaning and enhance qualitative research's validity by using the original language as long as possible. Therefore, I need to translate their answers into English first, and this translation process is the Pre-Stage in my data-analyzing (Figure 5).

In the study at hand, I only focus on a specific open question in the third group, which is "As a teacher, what are any other professional needs that I still lack when implementing Marine Education?". This particular question was chosen because I believe that this question can help me understand teachers' truly professional development needs in implementing Marine Education, especially they already have participated in this training course. Second, it is useful feedback information for the TMEC and can be used for improving the current version of the Marine Educator Training Course based on this study's findings in the future.

### **3.3 Qualitative Content Analysis (QCA)**

Content analysis is a commonly used qualitative research technique that included all types of written texts (Hsieh & Shannon, 2005, 1277; Bengtsson, 2016, p.10). This data collection and analytical approach aim to provide a contextual description and interpretation of a phenomenon. Qualitative Content Analysis (QCA) is mainly suitable for the researcher who pays attention to the high quality of both data description and interpretation (Holloway & Galvin, 2017, p.3; Vaismoradi & Snelgrove, 2019, p.x). In this study, I am focusing on the teachers' development professional need through teachers' perspectives. Therefore, I need to make sure the quality of description and interpretation obtain the real thoughts from responders in this study. According to what I already mentioned above were collected through the open questions among the e-questionnaire. Therefore I choose QCA to analyze my data, and it can make sure those data will be properly interpreted and shown descriptively.

### **3.4 Data analysis**

According to Bengtsson (2016), there are 5 steps to follow in QCA data analysis: one pre-stage and 4 stages: Pre-stage Translation, Stage 1 - Decontextualisation, Stage 2 - Recontexttulation, Stage 3 - Categorisation, and Stage 4 - Compilation in this study (Figure 5).



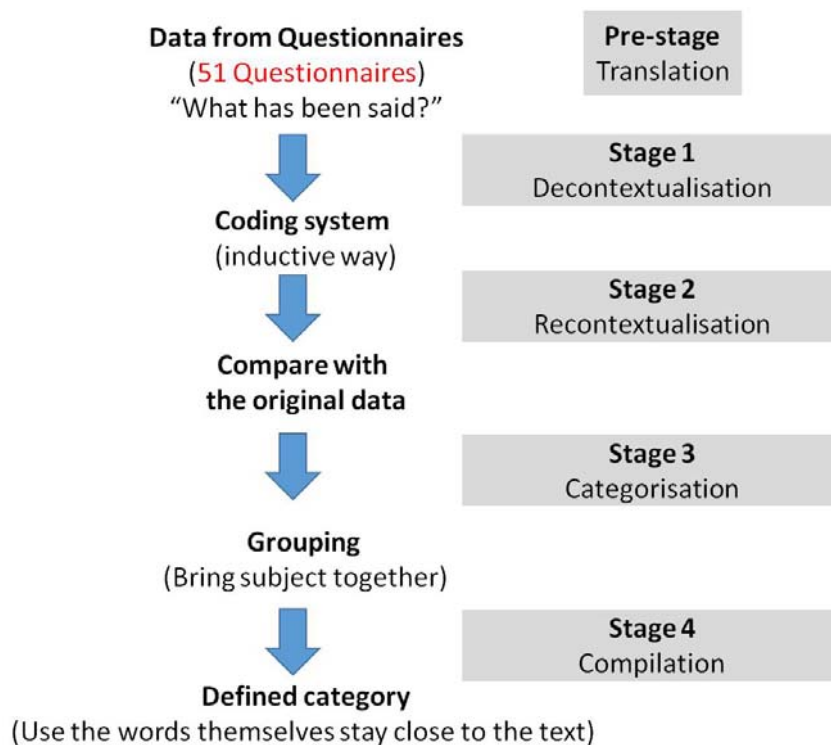


Figure 5. An overview of the Qualitative Content Analysis (QCA) process in this study (Bengtsson, M., 2016, p.9 modified by author).

In the Pre-stage, the data was translated into English before the data analysis started,. All answers were interpreted through the original version first and considered the scenario based on the context before translation (Appendix 3). In Stage 1, I used the inductive way of coding frame so that I have to check my translating and coding for consistency (reliability). In Stage 2, the coding frame must be adapted to fit my material, i.e., to be valid (Schreier, 2012, pp.8-9). My codes were created by short sentences because they can ensure the real meaning still can be observed after translation. After all the codes were created, the codes with similar meanings were sorted by sub-grouping as Stage 3. In this Stage 3, each subgroup contains several short sentences with similar meanings. Classifying specific information as an instance of a category could easily subsume them under a more generalized concept. In the end, those subgroups were categorized in Stage 4. Categorizing by generalized concept produces new information for the interpretation of my results.

In Table 2, there are some examples of the QCA process in grouping the codes. First, the

original answers in the Chinese version were translated into English. After translating into the English version, I break them into a short sentence to be my code. In order to keep the initial meaning in the sentence, I kept the short sentence the same as the code itself. For example, I kept the initial sentence of “Guided demonstrations on different topics” to the same code content of “Guided demonstrations on different topics.” However, for the longer sentence, I tried to modify the sentence depended on the meaning in 2 strategies of reduction, such as leaving out and generalization (Mayring, 2014, pp.35-36). For example, I split the initial sentence content of “The related marine education knowledge of elementary school is limited, and it can be effective to be integrated into the MOE-mandated course” into the two code contents. One content is “The related marine education knowledge of elementary school is limited,” and the other is “It can be effective to be integrated into the MOE-mandated course.”

After I finished creating codes, Table 2 shows that the clear QCA process by four examples, I sub-grouped codes with a similar meaning in the way that I was mentioned above in Stage 4 into four different subgroups. When the 4 sub-groupings were done, I tried to categorize them by a definitional theory, for example I categorized Group 1 Professional knowledge of Marine Education to Teachers' Marine Education Content Knowledge (Mayring, 2014, pp.37-38). Because, in this study, the content knowledge of Marine Education should be met to the professional knowledge of Marine Education were proposed by responders.

Table 2. The examples of the QCA process in grouping the codes (Appendix 3).

The examples of the QCA process				
請問您身為一個老師，還有哪些是在教授『海洋教育』這門課時，仍然缺乏的專業需求？	As a teacher, are there any other professional needs that I still lack when implementing "Marine Education"?	Code for professional needs	Sub group	Category
海洋科學相關	<p>“Knowledge related in Marine science”</p> <p>Other examples:                      “Professional theory”, “The cause of the phenomenon”,                      “Lack of the sense of big concepts”</p>	Knowledge related to Marine science	Group 1 Professional knowledge of Marine Education (ME)	Teachers’ Marine Education Content Knowledge
更多教學實際經驗的分享	<p>“More sharing of practical teaching experience”</p> <p>Other examples:                      “Making Marine biological specimen”, “Can I add the field operations and experience into the course”,                      “Editing tutorial videos”</p>	Sharing practical teaching experience	Group 2 Sharing practical and experiences	ME Technological & Pedagogical Knowledge
國小相關的海洋知能有限，能融入部訂課程，成效更大。	<p>“The related marine education knowledge of elementary schools is limited, and it can effective to be integrated into the MOE-mandated courses.”</p> <p>Other examples:                      “Choose the familiar course to conduct”, “There is no standard course for marine education currently.”</p>	It can effective to be integrated into the MOE-mandated courses.	Group 3 Difficulty in integrating ME course	ME Cross-Disciplinary Competency
缺同校協同教學師資	<p>“Lack of co-teaching teachers”</p> <p>Other examples:                      “Need a license”,                      “Insufficient time for studying and learning”</p>	Lack of co-teaching teachers	Group 4 School & Colleagues Administrative and Teaching Support	ME Administrative and Teaching Support within Schools

### 3.5 Basic information of responders in this study

In this study, there are 173 participants who attended the Marine Educator Training Courses held in 2017-2019, and 51 responders answered the e-questionnaires of this study. The total recovery rate of this questionnaire is only 29.5 %. There are more female participants (29, 57%) who responded than males (22, 43%) who joined in this study.

#### 3.5.1 Teaching years of responders in this study

The teaching year of these responders is separated into 4 categories: (1)1-5, (2) 6-15, (3) 16-25, and (4) 26-35 (Table 3). The highest peak group is located at responders who teach between 16-25 teaching years (35%). The lowest peak group is located at responders who teach more than 26 teaching years (18%). It shows that these responded participants in this study can be distinguished by their teaching years. In this Table 3, within those teaching experiences equal to less than 15 years, 10 among 24 responders only have around 5-year teaching experiences. On the other hand, there are 14 of all, have 6 to 15 years of teaching background. Also, there are 27 among 51 responders, already teach for more than 15 years. Therefore, the responders' data included all perspectives of beginners (1-5 teaching years), early-stage teachers (6-15 teaching years), and experienced teachers (over 16 teaching years) in this study.

Table 3. The responder' number and percentages of teaching years in this study.

Teaching year	Numbers of participants	Percentage (%)
1-5	10	20%
6-15	14	27%
16-25	18	35%
26-35	9	18%
Total	51	100%

### 3.5.2 Educational backgrounds of responders in this study

In this study, the majority of them (49, 96%) have higher educational degrees. A majority portion, 37 responders (73 %) of all, have at least a master's degree or even Ph.D.; the second portion (12, 24 %) has bachelor degrees, and only 2 of them (4%) have only associate degrees. Therefore, the responders in this study can be distinguished into two groups. One group of responders have a bachelor's degree or less (14, 28%); the other group has a master's degree or higher (37, 73%).

All the responders' can be divided into the Natural Science field and the Human Science field in Table 4. A large portion of teachers (35, 69%) are from the Human Science field, and only 16 participants (31%) are from the Natural Science field. Hence, this Marine Education training course could be professional and practical for those teachers who graduated from the Human Science field.

Table 4. The graduated categories of responders in this study.\*

<b>Graduated Categories</b>	<b>Numbers</b>	<b>Percentages (%)</b>
Natural Science field	16	31%
Human Science field	35	69%
Total	51	100%

\* All responders graduated from different departments. In order to understand do they have different TPCCK and professional needs. We divided their departments into 2 categories, natural science, and human science fields.

### 3.5.3 Service unit of responders in this study

Of these responders, 53%, more than half of them (27 among 51) are from Elementary school, and 22 % (11 among 51) are from junior high school. Then 12% (6 among 51) are from the upper secondary schools, which are the same percentages within the senior high school, complete secondary school, and vocational high school, all 4%

(which 2 among 51). The last group, others, also have 14% includes one teacher-student, one museum employee, two employees in government units, and two NGO members who are trainer and volunteer (Table 5).

Table 5. The service units of responders in this study.

<b>Service Unit</b>		<b>Numbers</b>	<b>Percentage (%)</b>
Elementary school (Grade 1-Grade 6)		27	53%
Junior High School (Grade 7-Grade 9)		11	22%
Upper	Senior High School (Grade 10-Grade 12)	2	12%
Secondary	Complete secondary School (Grade 1-Grade 12)	2	
Schools	Vocational High School (Grade 10-Grade 12)	2	
Others	Taipei City Ocean Education Resource Center	7	14%
	Institute of Social Education, e.g. Museum, etc.		
	Non-Governmental Organization, NGO		
	State-owned business		
	Government Unit (Retired)		
	Teacher-Student		
Total		51	100%

## 4. Findings

In order to answer my research questions, this specific open question, *As a teacher, are there any other professional needs that I still lack when implementing "Marine Education"?*, were collected through my e-questionnaire. The text from those answers was translated, coded, reduced, grouped, and categorized with QCA as mentioned before. The categorized data tried to relate to teacher's development professional needs under my 5 concepts in my conceptual frameworks. Their answers can provide insight for missing parts of this training course because maybe participants still feel lacking even though they already attended this training course.

After data analysis, 63 codes emerged from the data about teachers describing their professional needs even after their training. Among 51 responders, 36 codes were found from primary school teachers, 14 codes from junior high school teachers, 6 codes from upper secondary school teachers, and 7 codes from others (Table 6).

Table 6. Total codes of teachers' professional needs were collected among responders.

Service Unit		Responders		Codes	
Primary school teachers		27		36	
Junior high school teachers		11		14	
Upper secondary school teachers	Senior High School	6	2	6	2
	Complete secondary School		2		1
	Vocational High School		2		3
Other	Taipei City Ocean Education Resource Center	7	1	7	0
	Institute of Social Education, e.g. Museum, etc.		1		1
	Non-Governmental Organization, NGO		2		2
	State-owned business		1		1
	Government Unit (Retired)		1		2
	Teacher Student		1		1
Total		51		63	

According to the contents and meaning within these codes, 4 subgroups could be divided as follows: (1) Group 1 Professional Knowledge of ME, (2) Group 2 Sharing Practical Experiences, (3) Group 3 Difficulty in Integrating ME course, and (4) Group 4 School & Colleagues Administrative and Teaching Support (Figure 6, Appendix 4). I will describe how I divided them into these 4 subgroups in the following sections.

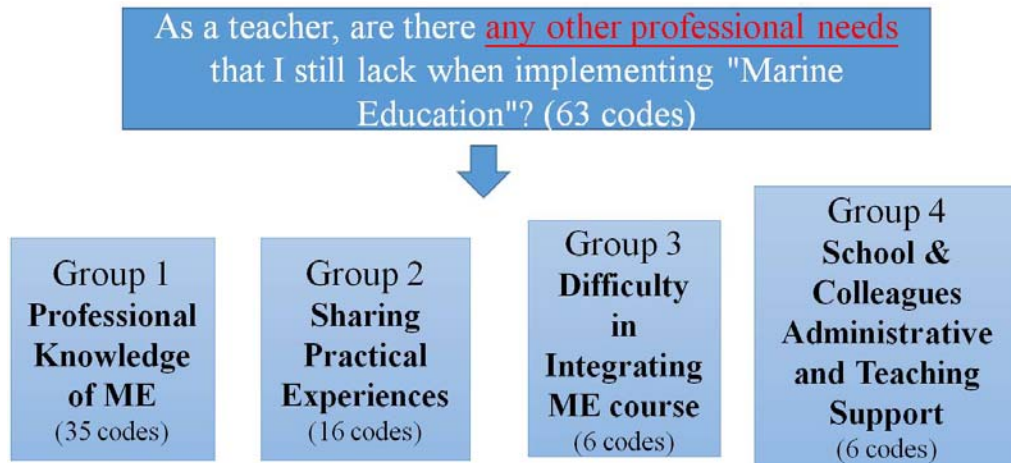


Figure 6. 4 subgroups are divided based on the contents and meaning within all collected codes.

#### 4.1 Relating codes for Group 1 Professional Knowledge of ME

For those codes contents with the knowledge or professional knowledge and related codes (Appendix 4), such as ‘*insufficient marine knowledge needs to deepen and broaden,*’ ‘*each subject has its own professional knowledge,*’ and ‘*the related marine education knowledge of elementary schools is limited,*’ etc. belong to this group professional knowledge of Marine Education (ME). However, there still have a majority of descriptions related to how teachers felt still lack professional marine resources in Marine Science, five themes of Marine Education in Taiwan, and the content of lesson plan, etc., when they implement Marine Education, among these codes in this group (Appendix 4). Such as ‘*not major in this area especially Marine Science, “(1) Marine leisure, (2) Marine culture, (3) Marine society, (4) Marine science and technology, (5) Marine sustainability,*’ *it is impossible to develop*



*relevant knowledge in the elementary schools' teacher training education,' and 'have to put a lot of effort into preparing lesson as an untrained teacher without enthusiasm,' etc.*

All codes were mentioned above could match the general concept of Professional knowledge of Marine Education (Appendix 4). Therefore, I grouped these codes into Group 1 Professional Knowledge of ME as well. In the end, 35 codes belong to this subgroup. Among these 35 codes, 27 were proposed by primary school teachers, 6 of them were from junior high school teachers, and only 2 of them were from others. However, none of the upper secondary school teachers proposed their needs in this subgroup. The result seemed to indicate the primary teachers were the main group who felt little confidence, which represented asking for more needs on professional Marine Education Knowledge than others. Clearly, primary school teachers' results resonated with two specific codes just mentioned above. They thought they were untrained of Marine Education Professional Knowledge in their training education levels.

#### **4.2 Relating codes for Group 2 Sharing Practical Experiences**

In this group, the majority of descriptions are related to 2 parts. One is the overlapping code's contents with teaching or practical experiences and related codes, such as *'reading marine-related references deepen the teaching experience,' 'practical knowledge', and 'can I add the field operations and experience into the course.'* In this part, participants still feel that they lack guided demonstration of teaching practical experience and professional training. The second one is that they need actual field participation or professional and operational skills such as *'making biological specimens,' 'have complete lesson plan with teaching materials as references,' 'more study places to provide teachers with professional upgrades,' 'editing tutorial videos,' and 'actual field participation,' etc.* (Appendix 4). Even though these codes were not consistent, these 2 parts still relevant to practical experiences, no matter these

experiences from their own or others. Therefore, I grouped these codes into Group 2, Sharing Practical Experiences, and 16 codes belong to this subgroup.

Among these codes, junior high school teachers, 7 out of 16 codes, seemed to have more demands than the other 3 groups. The result might indicate that junior high school teachers are not only focused on delivering the knowledge but also want to apply it in practice. That is the reason why they felt higher demand for practical experiences.

#### **4.3 Relating codes for Group 3 Difficulty in Integrating ME course**

In this group, the descriptions are more diverse into 3 parts. The first part is related to ME as an integrated course that is more focused on how to integrate ME into MOE-mandated courses, such as *'it is an integrated course,'* and *'it can effective to be integrated into the MOE-mandated courses'*; the second one is related to ME as an inter-disciplinary or cross-disciplinary course, and they don't have this profession of inter- or cross-disciplinary to implement it, such as *'marine education is a cross-disciplinary course,'* *'professional familiarity with interdisciplinary marine courses.'* The last part is related to the standard of implementing ME currently because they do not know how to conduct ME without standardization, such as *'there is no standard course for marine education currently,'* and *'choose the familiar course to conduct'* (Appendix 4). The result pointed out that teachers usually conduct their courses with a course outline, and this outline usually follows by learning objectives in the National Curriculum. Currently, it still without a clear learning objective in Marine Education of Taiwan and the reason is that Marine Education is not a MOE-mandated course yet. Although there are *Grade 1-9 Curriculum Guidelines Major Issues (Marine Education)* and *Guidelines of 12-Years Basic Education Major Issues (Marine Education)*, it might have differed for the teacher to implement it between integrated and single courses. Those codes more teachers' relevant opinions of conducting this course,

therefore these codes were grouped into Group 3 Difficulty in Integrating ME course. There are only 6 codes that belong to this subgroup.

Among these codes, all level teachers proposed the same numbers of codes except none from junior high school teachers. However, junior school teachers asked for more practical experiences maybe could be viewed as another perspective related to this subgroup's concept.

#### **4.4 Relating codes for Group 4 School & Colleagues Administrative and Teaching Support**

In this group, the descriptions also can interpret into 3 parts. The first part is related to school support. The code is '*school support*'; the second one is related to the teaching team's mastering, communicating, and co-teaching to implement ME topics together. Such as '*communication among teachers*,' '*must be organized a teaching team to master and implement ME topics*,' and '*lack of co-teaching teachers*.' This one is related to the colleagues' supports in their school environments. The last part is related to the individual feeling of time management in learning and studying and need a license to conduct it, such as '*insufficient time for studying and learning*' (Appendix 4). Even though these codes were not consistent, these 3 parts can still be viewed as support from teachers and schools within the school structure. Therefore, I grouped these codes into Group 4 School & Colleagues Administrative and Teaching Support. There are also only 6 codes that belong to this subgroup.

Among these codes, all level teachers proposed their needs; however, the primary school teachers still slightly higher than others. The reason might be that the primary school teachers are the teachers who usually have to teach the main subjects alone. Therefore it is lonely and exhausted without any partners in the same environment.

#### **4.5 Subgroups connected to 5 theoretical concepts under teacher's development professional needs in this study**

After dividing all the codes into 4 different subgroups, they were categorized and connected to the five concepts I discussed in this conceptual framework (Figure 7). In Group 1, Professional Knowledge of Marine Education, this is related to the concept of Marine Education Content knowledge (CK) (Hong, & Hao, 2018, p.448). Therefore Group 1 can be related to Teachers' Marine Education CK. For Group 2, sharing practical experience is related to the concept of Marine Education Pedagogical Knowledge (PK) (Hong, & Hao, 2018, p.448). Although there was only one technological need, '*editing tutorial videos*', proposed within 63 collected codes, responders still described using videos or computers to conduct Marine Education in the classroom, which is related to another question of Marine Education implementations that were not shown in this study. Hence, Group 2 can still be related to Teachers' Technological knowledge (TK) & PK. According to these two group associations with concepts, they could combine and integrated as a package of Marine Education TPACK (Hofer, & Swan, 2008, p178).

Group 3, difficulty in integrating the Marine Education course is related to the lack of competency to teach Marine Education and viewed Marine Education as an inter-disciplinary or cross-disciplinary course. Consequently, it could categorize as Marine Education cross-disciplinary competency (Haney, & Lumpe, 1995, pp.191-192). Therefore, the 6th principle of Ocean Literacy, the ocean and humans are inextricably interconnected, could organically be related to this Marine Education cross-disciplinary competency (UNESCO, 2017b, pp. 99-101).

Group 4 mentioned support within the teaching environment included school, colleagues, and administrative supports. Therefore, Group 4 can be related to Marine Education administrative and teaching support within schools. However, this category was not covered when TMEC designed this Marine Educator Training Course (Haney, & Lumpe, 1995, p.192).

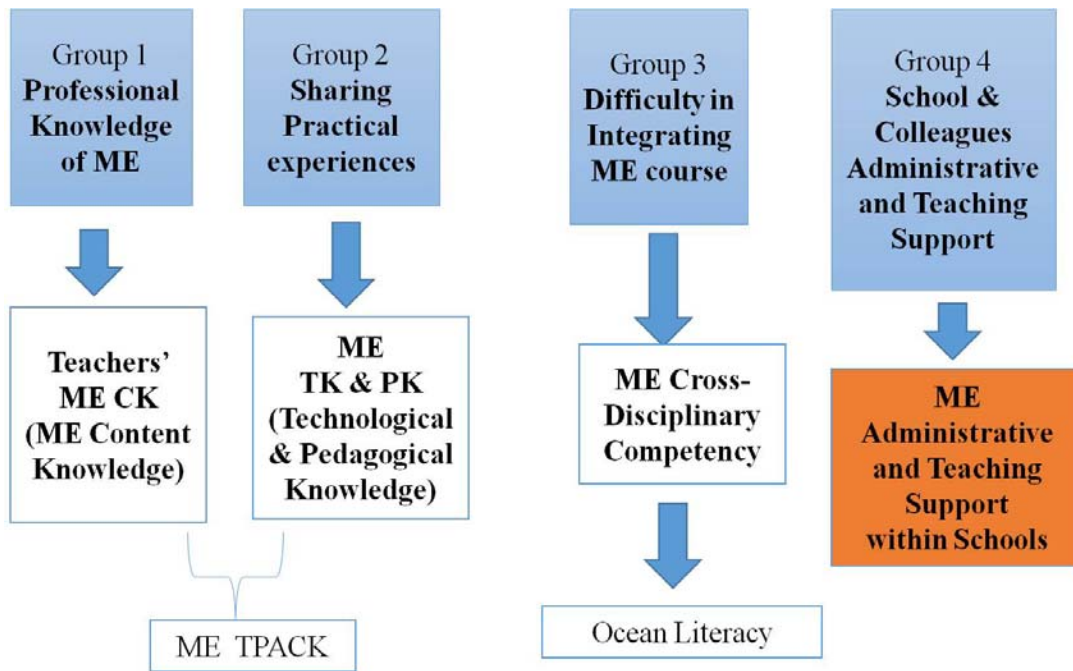


Figure 7. The connection between 4 subgroups of my results and 5 theoretical concepts under teacher's development professional in this study.

#### 4.6 The main findings of the study

Based on the summary results in this study (Table 7), it is obvious to see those responders from all levels shown a vital requirement, 51 among 63 codes, in professional needs of Marine Education TPACK even though they already attended Marine Educator Training Courses.

Table 7. The number of codes by teachers' categories in this study.

<b>Category of teachers</b>	<b>Number of codes</b>
<b>ME TPACK</b>	
Primary school teachers	31
Junior high school teachers	13
Upper secondary school teachers	3
Others	4
Total	51
<b>Ocean Literacy</b>	
Primary school teachers	2
Junior high school teachers	0
Upper secondary school teachers	2
Others	2
Total	6
<b>ME Administrative and Teaching Support within schools</b>	
Primary school teachers	3
Junior high school teachers	1
Upper secondary school teachers	1
Others	1
Total	6

Despite the Marine Education TPACK is already a combination package with associated concepts of group 1 and 2 associations, two groups of teachers are the most needed population that need this professional enhancement. The first highest group is primary school teachers.

More than half of codes in Marine Education TPACK, 31 among 51, were proposed by them; the second group is junior high school teachers. They presented 13 among 51 codes, which is a quarter of the codes. For the upper secondary school teachers and others who have small and similar amounts of codes, only 3 or 4 among 51 were mentioned related to Marine Education TPACK. It also shows in Table 6, the collected numbers of codes (50) are more than the number of responders (38) within these two groups. Therefore, both of the data indicated that the Marine Education TPACK is a higher requirement for basic education teachers than others.

For Ocean Literacy (Table 7), this is a small and equal need for participants except for junior high school teachers. It was not included in this Marine Educator Training Course when TMEC designed it. Besides, participants might expect that this Marine Educator Training Course can help them learn and know how to implement Marine Education practically in the classroom after they attended it. Therefore, Ocean Literacy is not even a purpose to foster.

According to the Marine Education administrative and teaching support results within schools, it is not linked to any concepts within my 5 conceptual frameworks (Figure 4). However, there are still 6 codes were proposed by all responders, and primary school teacher is still the highest group, 3 codes among 6, among them (Table 7). Although the Ministry of Education, R.O.C., added Marine Education as one of the major topics and was already officially implemented in 2011, it still not belongs to one of the MOE-mandated courses. Therefore, it is not easy for primary school teachers to conduct a general subject with an integrated Marine Education topic, especially since most primary school teachers have to conduct many MOE-mandated courses and take care of students. Compared to other groups of teachers, it might be why it is not easy for Marine Education initiators in a primary school environment to have school and administrative support within their own environment.

## **5. Discussion and conclusion**

The Science Teacher Professional Development Framework proposed by Haney and Lumpe (1995, pp.191-192) for Science education reform in the USA. There was three-phase in this framework which were (a) planning, (b) training, and (c) follow-up. Regarding the teacher professional development framework, teacher professional needs are not only focused on providing the professional knowledge of specific objects but also included teachers' competency of this specific subject and a support system in their teaching environment. Therefore, this study could be a representation of professional development; it provides a clear picture of needs from teachers' perspectives. It is also important and useful to have individual professional training and set up the support systems such as teacher workgroup and administration in schools when designing the teacher training program.

Based on my research question, I planned to identify the professional needs teachers still required after this training course. From my QCA analysis, the findings of (1) Marine Education TPACK, (2) Ocean Literacy, and (3) Marine Education Administrative and Teaching Support within Schools that is answered my research question in this way. For the following sections, I will describe my findings separately, how these findings answer my research question, how they related to my conceptual framework, and what observations I have in developing Marine Education in Taiwan.

### **5.1 Teachers in different school levels have different levels of demand**

In my findings, the professional need in Marine Education TPACK could divide responders into two groups. One group is basic education teachers, such as elementary and junior high school teachers; the other group is upper secondary school teachers and others. The reason might be related to their educational background differences and different levels of Taiwan teacher training experiences. In this study, two-thirds of respondents from the human science field, and only one-third of them are from the natural science field (Table 4). It



means that responders in this study could already have a different level of Teachers' Marine Science Content Knowledge because of their educational background. Wu (2017, p.27) mentioned that marine education is usually regarded as a category of professional education, and it is a more related subject in vocational schools or colleges. Sheu (2011, p. 62) mentioned that most of the research on national elementary school teachers' professional competence focuses on teachers' general teaching professional competence. It is relatively limited to explore the professional competence of teachers in individual fields is relatively limited. Hence, for basic education teachers, their majors are more relevant to general education such as Language Arts, Social Studies, Mathematics, and Arts than subject professional education for upper secondary school teachers such as Natural Sciences, Chemistry, Physics, and Biology. In other words, teachers' personal, educational background might increase the gap of Teachers' Marine Science Content Knowledge while taking this Marine Educator Training Course.

This gap of Teachers' Marine Science Content Knowledge also confirmed by code contents proposed by primary school teachers were mentioned in my findings. Ironically, marine education is a new field for basic education teachers, which is why TMEC started to design and plan this Marine Educator Training Course in Taiwan (Taiwan Marine Education Center, 2020a). Nevertheless, all the responders have already attended this Marine Educator Training Course. The primary school teachers still pointed out that they are untrained and impossible to develop Marine Education-related knowledge in primary school teacher training. Hwang, Hong, and Hao (2018, p.448) observed that teachers viewed a higher value of obtaining PCK more than PK and CK. It matches the main professional needs of my responders. Shulman (1986, p.9) mentioned that teachers usually expected to obtain useful improvement in their teaching after attending a teachers' professional development program. Hence, their feelings could be explained by still lacking PCK of Marine Education, and they do not feel that they have enough ability to present its concept.

Along with technology development, it plays a more and more important role in teaching (Rittel & Webber, 1973, p.166), and teachers can use technologies properly with teaching approaches to conducting the subject knowledge, which means teachers have Technological Pedagogical Content Knowledge (TPACK) (Koehler, 2008, p.2). Although the TK was only mentioned once among all answers in my study, I believe the responders already have the basic skills and understanding to utilize and combine the technologies in their teaching approach (Rittel & Webber, 1973, p.166). In my study, 41 responders have over 5-year teaching experience, and surprisingly the results still pointed out that they believe that they still lack Marine Education TPACK even they already attending this training course (Table 3).

According to what I have mentioned above, the revised version of the Marine Educator Training Course in TMEC should be tailored-designed for different school levels, such as participants in basic education and upper secondary school levels.

## **5.2 Possible potential for the sixth principle of OL**

In my findings, most responders in this study, 44 among 51, are teachers (Table 5). The biggest group is the teacher who serviced in the primary and junior high schools among all of the teachers. Therefore, they have an obligation to conduct the MOE-mandated curriculum and school-developed curriculum listed in the *Curriculum Guidelines of 12-Year Basic Education* (Ministry of Education, R.O.C., 2014, pp.13-16). While Marine Education does not belong to the MOE-mandated curriculum, teachers can still integrate Marine Education into other subjects (Table 1) based on the *Grade 1-9 Curriculum Guidelines Major Issues (Marine Education)* or *Guidelines of 12-Year Basic Education Major Issues (Marine Education)*.

Many researchers in Taiwan agree that it is hard for teachers to teach Marine Education without any proper multidisciplinary teaching guideline (Wu, 2010, p.27; Lwo, 2018, p.9), and the educational purpose of Marine Education in Taiwan is still unclear (Hung 2010, p.33; Wu, 2010, p.25; Zhou, 2015, p.9). NOAA and NMEA already released several Ocean

Literacy outlines online (NOAA, 2013). For example, Ocean Literacy-The Essential Principles and Fundamental concepts of Ocean Sciences for Learners of All Ages could be a good reference for teachers. There are seven major principles within Ocean Literacy, but teachers could start from one principle first. The sixth one, the ocean and humans are inextricably interconnected, could be a potential start entrance for teachers if they have no ideas how to implement Marine Education.

Besides, there already has a tool kit, Ocean Literacy for all, published by UNESCO in 2017 (2017b, pp.99-101). This tool kit already included well-designed teaching activities, and some of them are linked to the sixth principle. It is easy for teachers to download it and use these materials to implement Marine Education. Maybe the English version could be an issue, but it is easy for teachers to find the translation software to solve this problem easily nowadays.

### **5.3 The importance of school internal support**

According to my findings, the teachers mentioned Marine Education Administrative and Teaching Support within School is a united demand related to the teaching team, co-teachers, teacher communications, and school support. These were proposed by different teacher levels separately (Table 7). Haney and Lumpe (1995, p.192) proposed a three-phase in the Science Teacher Professional Development Framework. The third, follow-up, phase provides continuous classroom assistance by school staff, such as administrators, teacher leaders, community members, university collaborators, etc. Karlberg and Bezzina (2020, p.2) indicated that beginning and inexperienced teachers are easily exhausted and struggle to design curriculum flexibly. Although there are only 10 responders who have less than 5-year teaching experience (Table 3), there are still 38 of them from elementary and junior high schools in this study (Table 5). Besides, Marine Education is not a familiar subject for them if they do not have the natural science field. For this reason, teachers could view as beginning

and inexperienced ones while they are learning and implementing Marine Education no matter how many teaching years they already have. This inexperienced feeling in Marine Education could explain to lack of Marine Education TPACK and self-efficacy. Therefore it might cause some stress in teachers while they are implementing Marine Education in the classroom. It might be similar to technostress observed by Dong et al. (2020, p.147). They found out teachers have technostress when they lack TPACK-level and computer self-efficacy, and it also could be reduced when teachers have external support from school and peers.

Although Wu et al. (2018, p.20) suggested that the Ministry of Education, R.O.C. could improve the current situation by Marine Education network learning platform, Joint Pilot Schools, and assistants from teacher training institutions TMEC and local marine resources centers which already exist for many years. For teachers, internal support from peers and administrators is most valued and acknowledged.

#### **5.4 Implications**

In this study, my results revealed that these two levels of Marine Educator Training Courses are still not enough for teachers to feel confident to implement Marine Education in the class after training. Based on the teachers' perspectives analyzed in this study, my findings indicated that this Marine Educator Training Course still lacks sufficient Marine Education TPACK guidelines for the different levels of school teachers, especially for primary and junior high school teachers. The possible reason could be related to the teacher's training education process. Simultaneously, Teachers' Marine Science Content Knowledge influenced their basic knowledge and understandings of Marine Education. It might be relevant to Teachers' educational background. In the end, internal support from schools, such as peers, and administrators, is also an important factor to encourage teachers to implement Marine education in the classroom.

## **5.5 Quality, trustworthy, justifications, and transparency**

In qualitative research, credibility, transferability, dependability, and confirmability should be covered to maintain trustworthiness (Shenton, 2004, p.64). My clearly described process as well as my extended collaboration in this project speak to the dependability and transferability of my findings. The credibility of the research and of myself as a researcher can be seen in what follows. In this study, the responders attended the Marine Educator Training Courses ranging from 2017 to 2019, separately. The key issue of internal credibility in this study could be related to the consistency of training course contents within these 2 years. In 2017, this was the beginning phase of this Marine Educator Training Course. Therefore TMEC was the only institute responsible for planning and invited experts to conduct the course by the structure of Marine Educator Training courses they designed. As the course went smoothly, in 2018, TMEC decided to allow the local Marine Education Center around Taiwan to hold this training course by the same structure and invite experts by their own needs to conduct it. Although, TMEC still took the responsibility to check their lesson plans before the course was conducted. It was still difficult to have a 100% guarantee that the course had been conducted with the same pedagogy and the depth of content they delivered. Therefore, I was not only collecting sociodemographic indicators, such as gender, years of teaching, the graduating universities, departments, service units, positions, and school categories and locations but also the year and level of training courses they attended, to make sure I can obtain detail basic information of responders.

Participants and I are Chinese native language speakers, so that this e-questionnaire was designed, written, and conducted in Chinese. In qualitative research, language could be a factor that might strongly influence interpreting data in the content analysis (Mayring, 2014, p.31). Nes, Abma, Jonsson, and Dee (2010, p.315) pointed out the meaning could be lost in the translating process because translation is an interpretive act. It also influences when the

researcher is analyzing in another language than his/her native language. They recommended using the original language as long as possible; it can reduce the loss of meaning and enhance qualitative research validity. This means that I should translate my results and findings into English after understanding my Chinese data to aim for a good representation and understanding of the participants' descriptions. Therefore I only can do my best even though it always includes a risk that something in the meaning is lost or changed. This however speaks generally to the trustworthiness of my research.

Ensuring the e-questionnaire can represent the reality of the trained teachers' professional needs contributes further to the establishment of trustworthiness in this study. Before I started to collect data from participants by the e-questionnaire, there were 4 teachers not joining this training course who were asked to fill this questionnaire for the pilot test. 2 teachers have a science-related educational background, such as biology and earth science, 1 major math education, and the last one is a marine educator. The only marine educator answered it easily, but the rest mentioned that they did not attend this course. They did not have any specific Marine Education lesson plan that can be implemented in their classroom. Based on their feedback, I believed these questionnaires are suitable for participants who attended this Marine Educator Training Courses. This pilot test helped me to ensure the e-questionnaire is specific and distinguished the difference between trained and untrained teachers in this study.

Moravcsik (2019, p.3) indicated three dimensions of transparency: data, analytic, and production transparency. In this study, all the responders have to finish this e-questionnaire question in orders that I already described clearly and in detail in the Methodological approach section for all these three dimensions mentioned above. I need to emphasize that I only use some of the collected data in this study because those data can directly answer my research question. For the dependability, I still have to point out that before all responders answered this specific question related to my research question, they needed to answer and

describe that "after the training course, did you actually try to implement the lesson plan content of the marine education you designed in the classroom?." I believed when they answer this open question, and it would help them remind the true feeling of implementing Marine Education. Therefore, they wrote their true needed from their empirical experiences while they were answering the target question, "As a teacher, are there any other professional needs that I still lack when implementing "Marine Education?". I also attached a portion of data that I used for translation, coding, grouping, and categorized within this study, and it could be found in Appendix 3. The data I have shown in Appendix 3 could help me understand and reveal the professional development need through teachers' perspectives to discover the practical demand in implementing Marine Education. For the confirmability, I had been one of the group members who carried out this training course in 2017; I still viewed my role as a researcher in this study. Therefore I tried to discuss this question from a global perspective. For the transferability, I hope the Taiwan experience and the result in this study could be a potential reference of Marine Education in the Education for Sustainable Development (ESD) globally.

## **5.6 Ethical concerns**

There are a few ethical considerations that need to be addressed. It is important to note that I was involved in designing and planning this Marine Educator Training Course Project in 2017 as a postdoctoral fellow and provided the experts' list for consideration to conduct the course. Although there was a specific research assistant to do the administration work for this project, I still held some power as an administrator during the time and the project was taking place. As the one who had needed to write the final report of this project. This means that I have some subjective thoughts and understanding of this training course. However, this mainly affects the purpose of initiating this training course project and made it occurred. Except for this, there was no influence by me during the training sessions. Also, I did not

know any participants personally by the end of 2017. Therefore, I am confident that there have not affected their answers.

Before I started to do data analysis, 51 responders received an informed consent that was signed and returned. The informed consent promised for their names to be anonymous again and to inform the teachers that they had the right to withdraw from the study at any point during the data analysis process. Because the participants are Taiwanese, which also are Chinese native speakers, the invitation letter was written in Chinese. Informed consent also provided in both Chinese and English versions. The invitation letter and informed consent have been provided in Appendix I.

### **5.7 Evaluate the whole process**

There are several unexpected realizations in the whole process of this research. My unexpected realization relates to the data collection, the suitable approach in methodology, and the proper amount of data presented for a master thesis.

In the beginning, I wanted to do this research by mixed-method and I believed and expected that all the participants will be willing to answer my online e-questionnaires. However, I only collected 51 responders within 2 months, and the fixed questions I designed in my questionnaires were not representative enough to be the indicator to be shown as the quantitative report. Therefore, my collected data was more aligned with the qualitative report than the mixed-method.

There were three research questions when I started to do my survey, and I already analyzed all the data I collected and obtained the results. However, I realized that it was complicated to describe all the findings in this master thesis under the current conceptual framework after organizing my results. Therefore, I decided to address and analyze the most direct data for my master thesis to answer my most passionate research findings. Thus, I have to change my research question from 3 to 1, and I also have to modify my research question



to fit my research goal. If I could have a chance to conduct this research again, I would like to use a mix-method to analyze the data. First, I will develop the Marine Education TPACK indicators according to the literature as quantitative evidence, and it could help me understand the Marine Educator Training Course content. Second, I will use the same open questions in this study as qualitative evidence to obtain teachers' perspectives. Combining these two types of data could help me have a holistic picture of professional development needs in Marine Education for all teachers at different school levels in Taiwan.

Overall, I succeed and reach my goal in this research. My findings helped me to understand and reveal the teachers' professional development needs after Marine Educator Training Courses in Taiwan.

### **5.8 Suggestions for further research**

Within this study, I only analyzed and discussed the professional needs of teachers after they attended the Marine Educator Training Course. However, based on my current results, the teachers already showed their different needs in different levels of schools. At the same time, their educational backgrounds might be another factor that could impact their perspectives of implementing ME in the classroom. Therefore, this research could do a further continuous analysis of other data to have deeper insights.

In addition, some of the participants already implemented Marine Education in their schools by their school curricula. Therefore, it could be a good reason to do further interviews for understanding what kind of competencies they need on ME as a cross-disciplinary course. All of the results can provide a holistic point of view to help us interpreting the difference between theoretical and implemented perspectives about professional needs.

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## Appendix 1 Invitation Letter and Informed Consent

各位海洋教育者您們好，

我是芬蘭奧盧大學教育與全球化碩士班的研究生劉虹君，我的碩士論文是想了解『**海洋教育教師的專業需求**』。經臺灣海洋教育中心主任張正杰教授推薦，得知老師在海洋教育已經具備相當的海洋教育知能。因此特別針對**2017-2019**年曾經參與過『**臺灣海洋教育中心**』辦理的『**海洋教育者計畫**』的所有參與者進行此份問卷調查。

這是有關『**臺灣海洋教育教師專業需求**』的線上問卷，內容分為兩個部分：第一部分主要為選擇題，目的是收集參與者的基本資料、參與者對於培訓課的課程內容和上完培訓課後對於『**海洋教育**』的一些看法；第二部分為非選擇題，主要是要了解參與者在上過培訓課後實際執行海洋教育課堂授課的狀況。

請各位參與者能在2020年5月31日前完成此份問卷(約25分鐘)，線上問卷連結如下：

[https://docs.google.com/forms/d/e/1FAIpQLScMiV\\_P2untrUIbKdYqOUwUkt\\_HxX4J6-qza2J1CcihepYMA/viewform](https://docs.google.com/forms/d/e/1FAIpQLScMiV_P2untrUIbKdYqOUwUkt_HxX4J6-qza2J1CcihepYMA/viewform)

未來若因論文需要，有可能會在下半年期間(9-11月)，根據所分析的問卷內容從中挑選幾位參與者再進一步的進行線上中文訪談。訪談的部分，我會先透過E-mail寄出訪談邀約，詢問您是否有意願參與訪談與方便訪談的時間。此份問卷中所有的內容都是以不記名的方式設計，也保證您所填寫的問卷資料僅會作為此份碩士論文研究使用，非常感謝您的參與與配合。

學生 劉虹君 敬上

Hung-Chun.Liu@student oulu.fi

教育與全球化碩士學程

Master's Degree Programme in Education and globalization

芬蘭奧盧大學

University of Oulu, Finland

## Informed Consent

### Informed consent for participating in research

This informed consent form provides you as a research participant general information about the research, its purpose and your rights as a participant.

#### General information

I am, Hung-Chun Liu, a master's student in the Education and Globalization Master Program, at the Faculty of Education, University of Oulu. As a part of my studies, I am conducting a research in **Defining teachers' professional needs - A study of implementing Marine Education Training Course in Taiwan**. The purpose of my research is to understand Teachers' Professional needs in marine education. I kindly request your consent for collecting information from you for the research purpose by **E-questionnaire**.

All information will be used anonymously, respecting your dignity. No personal details that enable identifying you will be included in the analyses and reporting. Systematic care in handling and storing the information will be ensured to avoid any kind of harm to you. After all the information leading to identification of a person has been removed, **the information will be destroyed within five years after the thesis has been assessed and approved by the Faculty of Education and also related academic articles published.**

#### Voluntary participation

Your participation is completely voluntary. You have the right to withdraw from the research at any time without any consequences. You have the right to get information about the research. If you have questions may contact me at: Hung-Chun.Liu@student oulu.fi.

#### Confirming informed consent (multiple choice)

- I am willing to participate in the research.
- I allow the use of all data is collected by **E-questionnaire** for research purposes.
- I allow the information that I have provided to be stored and archived for further research use.
- I do not allow the information that I have provided to be stored and archived for further research use.

Date \_\_\_/\_\_\_/2020

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Signature and name (in capital letters)

#### Researcher

**Hung-Chun Liu**

[Hung-Chun.Liu@student oulu.fi](mailto:Hung-Chun.Liu@student oulu.fi)

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#### This thesis research is supervised by:

Elina Lehtomäki, Professor of global education, Oulu University

Audrey Paradis, University teacher & Researcher, Oulu University

Anne Pellikka, University teacher & PhD Researcher, Oulu University

#### More information about research ethics and informed consent:

Finnish Board on Research Integrity

<http://www.tenk.fi/en/ethical-review-in-human-sciences>

Social Sciences Data Archive

<http://www.fsd.uta.fi/aineistonhallinta/en/informing-research-participants.html#partIV-examples-of-informing-research-participants>

<http://www.fsd.uta.fi/aineistonhallinta/en/anonymisation-and-identifiers.html>

## Appendix 2 E-questionnaire

### 第一部分(Part One)-基礎資料(Basic Information)

\*必填

電子郵件地址 \*

.....

1. 性別 (Gender) \*

- 男 (Male)
- 女 (Female)

2. 教學年資 (Years of teaching) \*

.....

3. 學歷 (Educational Background) \*

- 大學 (Bachelor)
- 碩士 (Master)
- 博士 (PhD)
- 其他 : .....

3-1. 畢業科系 (Graduated Department) \*

.....

4. 畢業學校 (Graduated from) \*

- 傳統師範 (Traditional Teachers College)
- 師範大學 (Normal university)
- 一般大學 (General university)
- 科技大學(學院) (University of Science and Technology (College))
- 其他 : .....

5. 您所參與的海洋教育者培訓課程為 (Attended Marine Educator Training Course) \*

如果您兩階段的培訓課程都上過，請勾選兩個時段，感謝您。(If you have attended both training sessions, please tick both periods, thank you.)

- 2017 (民國106年)
- 2018 (民國107年)
- 2019 (民國108年)
- 其他 : .....

6. 您的培訓課程階級為 (The level of Marine Educator Training Course) \*

如果您兩階段的培訓課程於不同時期上的，請於下方詳述上課的時段(如：綠階-2017、藍階-2018)，感謝您。(If your two-stage training courses are held at different periods, please provide details of the class period below: eg. Green-2017, Blue-2018). Thank you.)

- 綠階 (Green Level)
- 藍階 (Blue Level)
- 兩者皆有 (Both)

7. 服務單位 (service unit) \*

- 國民小學 (Elementary School)
- 國民中學 (Junior High School)
- 完全中學 (Complete secondary School)
- 高級中學 (Senior High School)
- 高等職業學校 (Vocational High School)
- 大專院校 (University)
- 社教館所(如博物館等) (Institute of Social Education, e.g. Museum, etc.)
- 公司行號 (Companies)
- 政府單位 (Government Unit)
- 非營利組織 (Non-Governmental Organization, NGO)
- 其他 : .....

8. 職位 (Position)-先以服務單位區分 (First differentiate by service unit) \*

- 高級中學以下(國小、國中及高職) (Under high school: elementary school, junior high school, senior high school and vocational school)
- 研究所以下(研究所及大學院校含科技大學) (Under graduate school: graduate school and universities include science and technology universities)
- 社教單位 (如博物館等) (Institute of Social Education, e.g. Museum, etc.)
- 政府單位 (Government Unit)
- 非營利組織 (Non-Governmental Organization, NGO)
- 公司行號 (Companies)
- 在職進修師培生 (In-service Teacher Student)
- 師培生 (Teacher Student)
- 其他 : .....

### 高級中學以下職位問卷

#### 8.1. 職位 (Position)-依高級中學以下區分 (Differentiate by Taiwan's senior high school) \*

Just answer what is your current situation

- 公務人員 (校長、主計、護理師、營養師、職工等) (Public officials including principal, chief accountant, nurse, nutritionist, staff, etc.)
- 兼任教師 (主任、組長) (Part-time teacher including director, team leader)
- 班級導師 (未兼行政職) (Class Tutor not including concurrent administration)
- 科任導師 (未兼行政職) (Section Tutor not including concurrent administration)
- 代理、代課老師 (含支援人力、原民、本土語等) (Substitute teachers including support manpower, indigenous course, native language, etc.)
- 退休 (Retired)
- 其他: .....

#### 8.1.1 學校屬性 (School Categories)-是否為教育部核定之永續學校? (is it a sustainable campus approved by the Ministry of Education?) \*

永續校園包含項目在硬體方面包括「生態環境恢復與維護」以及「永續建築」兩大項目，從瞭解自身校園地域、文化、歷史與生態等特色，從而創造出完全不同且多樣的校園環境。而在軟體部分，各校對應校園環境改造，創造出各校教學特色的教學教材，未來更可配合鄰近不同教育特色的學校，更能形成緊密的環境教育網絡。(The sustainable campus contains two major projects, including "recovery and maintenance of ecological environment" and "sustainable building" in terms of hardware. It understands the characteristics of its campus, culture, history, and ecology, and creates a completely different and diverse Campus Environment. In the software part, each school has correspondingly changed the campus environment to create teaching materials with different teaching characteristics. In the future, it can cooperate with neighboring schools with different educational characteristics and form a close environmental education network.)

- 是 (Yes)
- 否 (No)
- 不知道 (I don't know)
- 其他: .....

#### 8.1.2. 學校屬性 (School Location) \*

- 臨海: 30分鐘內用走路的就可以抵達海邊 (Near the Sea: 30 mins walking distance to the coastal region)
- 靠海: 2小時車程內有可以繞近海的場域 (Close to the Sea: there are fields close to the sea within 2 hours by car)
- 不靠海: 2小時車程內沒有可以繞近海的場域 (Not close to the Sea: there are no fields close to the sea within 2 hours by car)
- 其他: .....

### 研究所以下職位問卷

#### 8.2. 職位 (Position)-依大學以下區分 (Differentiate by Taiwan's university) \*

- 教授 (Professor)
- 副教授 (Associate Professor)
- 助理教授 (Assistant Professor)
- 其他: .....

### 社福單位職位問卷

#### 8.3 職位 (Position)-依社福單位區分 (Differentiate by Institute of Social Education) \*

- 正職人員 (Regular staff)
- 約聘僱人員 (Contract staff)
- 志工 (Volunteer)
- 其他: .....

### 公司行號職位問卷

#### 8.4 職位 (Position)-依公司行號區分 (Differentiate by companies) \*

- 負責人 (Principal)
- 總經理 (General manager)
- 培訓講師 (Trainer)
- 行政人員 (Administration staff)
- 其他: .....

### 政府部門職位問卷

#### 8.5 職位 (Position)-依政府部門區分 (Differentiate by government unit)

.....

### 非營利組織職位問卷

#### 8.6 職位 (Position)-依非營利組織區分 (Differentiate by Non-Governmental Organization)

- 負責人 (Principal)
- 培訓講師 (Trainer)
- 行政人員 (Administration staff)
- 志工 (Volunteer)
- 其他: .....

第二部分(Part 2)、參加培訓課程的因素(The factor you attended this course)

1. 請問您參加培訓課程的理由？(Why do you participate in this training course?)\*

- 自己在學校推廣海洋教育多年，所以前來取得認證資格 (I participated in to get certification because I have been promoting marine education in school for many years.)
- 因為本校地理環境的關係，有意發展校本課程而前來參加 (I participated to develop the school-based curriculum because of the school's geographical environment.)
- 純粹想替自己增能而前來參加 (I participated it in to empower myself.)
- 因教育部的公文而被學校指派來參加 (The school assigned me to participate in because of the MOE official document.)
- 其他： .....

1.1 請問除上題所述原因外，您所就職的學校地理位置是否也是影響您參與培訓的因素？(In addition to the above reasons, is the geographical location of the school where you work also a factor that affects your participation in this training course?)\*

- 是 (Yes)
- 否 (No)
- 其他： .....

2. 請您勾選對此次培訓課程內容的感覺？(How do you think about this training course contents?)\*

- 目前所提供培訓課程的內容，增加了一半以上的是新知識 (More than half of new knowledge has been provided in this training course content.)
- 目前所提供培訓課程的內容，跟自己知道的知識如出一轍 (The content of the current training courses is exactly the same as what I already know.)
- 目前所提供培訓課程的內容，比自己知道的知識還少 (The content of the training courses currently provided is less than what I already know.)
- 其他： .....

3. 請問您上完培訓課後，您會如何定義【海洋教育】？(How do you define "Marine Education" after this training course?)\*

.....

4-1. 請問就目前【海洋教育】的【五個主題】中，您認為對老師的重要性依序為 (Please mark the "Five themes" in "Marine Education" in order of importance from the teacher's point of view)\*

五個主題為：(1)海洋休閒、(2)海洋文化、(3)海洋社會、(4)海洋科學與技術、(5)海洋永續與保育。請依其重要性排序，位置越前面表示越重要。(Five themes are: (1)Marine Leisure, (2)Marine Culture, (3)Marine Society, (4)Marine Science and (5)Technology, and Marine Resources and Sustainability. Please order them according to its importance. The more front position is, the the more important it is.)

.....

4-2. 請解釋您選擇上述答案的理由 (Please explain the reason why you choose this answer):\*

.....

5-1. 請問就目前【海洋教育】的【五個主題】中，您認為對學生的重要性依序為？(Please mark the "Five themes" in "Marine Education" in order of importance from the student's point of view)\*

五個主題為：(1)海洋休閒、(2)海洋文化、(3)海洋社會、(4)海洋科學與技術、(5)海洋永續與保育。請依其重要性排序，位置越前面表示越重要。(Five themes are: (1)Marine Leisure, (2)Marine Culture, (3)Marine Society, (4)Marine Science and (5)Technology, and Marine Resources and Sustainability. Please order them according to its importance. The more front position is, the the more important it is.)

.....

5-2. 請解釋您選擇上述答案的理由 (Please explain the reason why you choose this answer):\*

.....

第三部分(Part 3)、海洋教育課的實際操作 (Implementing the "Marine Education" course)

1. 請問上完培訓課後，您是否有嘗試實際在課堂中操作過您所設計海洋教育的教案內容嗎? (After the training course, did you actually try to implement the lesson plan content of the marine education you designed in the classroom?) \*

若選擇有的選項，請於下方1-1說明實際操作的情況 (If you choose an option "Yes", please explain it in the 1-1 below); 若選擇沒有的選項，請於下方1-2說明原因 (If you choose an option "No", please explain it in the 1-2 below)

- 有(Yes)
- 沒有 (No)

1-1. 請問您如何教授這門課? (How would you implement this course?) 字數限字 500字 (Word limit 500 words)

.....

1-2. 請說明無法在課堂上實際操作的原因 (Please explain the reason why you didn't implement in class)

.....

2. 請問哪些是您在教授這門課時會發生的困難? (What are the challenges when you implement Marine Education in the classroom) \*

.....

3. 請問您在教授這門課時，還需要哪些更進一步的資源或幫助? (For implementing this course, what do you need for further resources or help?) \*

.....

4. 請問您身為一個老師，還有哪些是在教授『海洋教育』這門課時，仍然缺乏的專業需求? (As a teacher, are there any other professional needs that I still lack when implementing "Marine Education"?) \*

.....

5. 請問您身為一個老師，您覺得第二外文能力(如英文或日文等)，是否會影響您學習並取得『海洋教育』的相關新知? (As a teacher, do you think that your second language ability (such as English or Japanese etc.) will affect you to learn and acquire new knowledge about "Marine Education"?) \*

- 是 (Yes)
- 否 (No)
- 其他: .....

5.1 請解釋您選擇上述答案的理由 (Please explain the reason why you choose this answer.): \*

.....

### Appendix 3 Original Data in this study (Chinese and English Versions)

No.	請問您身為一個老師，還有哪些是在教授『海洋教育』這門課時，仍然缺乏的專業需求？	As a teacher, are there any other professional needs that I still lack when implementing "Marine Education"?	The sentence for codes	Sub group
1	國小相關的海洋知能有限，能融入部訂課程，成效更大。	The related marine education knowledge of elementary schools is limited, and it can effective to be integrated into the MOE-mandated courses.	<ul style="list-style-type: none"> <li>➤ The related marine education knowledge of elementary schools is limited.</li> <li>➤ It can effective to be integrated into the MOE-mandated courses.</li> </ul>	Group 1 Group 3
2	需有證照及較多研習名額提供老師專業提升	Need a license and more study places to provide teachers with professional upgrades	<ul style="list-style-type: none"> <li>➤ Need a license.</li> <li>➤ More study places to provide teachers with professional upgrades</li> </ul>	Group 4 Group 2
3	實務知能	Practical knowledge	➤ Practical knowledge	Group 2
4	學校配合	School support	➤ School support	Group 4
5	知識面。	Knowledge	➤ Knowledge	Group 1
6	沒有	No	No	-
7	還好。因為是融入的課程，就挑自己熟悉的課程操作。	Ok. Because it is an integrated course, choose the familiar course to conduct.	<ul style="list-style-type: none"> <li>➤ It is an integrated course.</li> <li>➤ Choose the familiar course to conduct.</li> </ul>	Group 3 Group 3
8	五大議題分門別類的資源。海洋知識不足有再加深加廣的需求，但學習時間及研習時間不足。個人及環境漁村經驗與教學內容，不知如何有效與海洋教育做有組織及系統性內容設計。	Resources of five themes. Insufficient marine knowledge has the need to deepen and broaden, but there is insufficient time for studying and learning. Personal and environmental fishing village experience and teaching content, I don't know how to effectively design organized and systematic content with marine education.	<ul style="list-style-type: none"> <li>➤ Resources of five themes.</li> <li>➤ Insufficient marine knowledge has the need to deepen and broaden.</li> <li>➤ Insufficient time for studying and learning.</li> <li>➤ Don't know how to effectively design organized and systematic content with marine education.</li> </ul>	Group 1 Group 1 Group 4 Group 2
9	自己非這方面專業，尤其在海洋科學。	I am not major in this area, especially in marine science.	➤ Not major in this area especially Marine Science.	Group 1

No.	請問您身為一個老師，還有哪些是在教授『海洋教育』這門課時，仍然缺乏的專業需求？	As a teacher, are there any other professional needs that I still lack when implementing "Marine Education"?	The sentence for codes	Sub group
10	海菜的相關知識	Related knowledge of seaweed	➤ Related knowledge of seaweed.	Group 1
11	海洋新知	New marine knowledge	➤ New marine knowledge.	Group 1
12	無相關經歷	No relevant experience	➤ No relevant experience.	Group 2
13	對整個海洋教育還是感到陌生 缺乏大概概念的感覺	I am still unfamiliar with ME, lacking of the sense of big concepts	➤ I am still unfamiliar with ME.	Group 1
			➤ Lack of the sense of big concepts.	Group 1
14	關於海洋的認知	Cognition about the ocean	➤ Cognition about the marine.	Group 1
15	希望能有完整的教材及規劃供參考	Hope to have complete teaching materials and lesson plans as reference	➤ Have complete teaching materials and lesson plans as reference.	Group 2
16	海洋科學相關	Knowledge related in Marine science	➤ Knowledge related in Marine science.	Group 1
17	數據判讀、輔具教學、活動設計等	Data interpretation, teaching supplementary materials, activity design, etc.	➤ Data interpretation.	Group 1
			➤ Teaching supplementary materials.	Group 1
			➤ Activity design	Group 1
18	對於海洋休閒的實際經驗不足。	Insufficient practical experience in marine recreation.	➤ Insufficient practical experience in marine recreation.	Group 2
19	更多教學實際經驗的分享	Sharing of practical teaching experience	➤ Sharing of practical teaching experience.	Group 2
20	比較專業的理论，或是發生現象的原因	More professional theory, or the cause of the phenomenon	➤ Professional theory.	Group 1
			➤ The cause of the phenomenon.	Group 1
21	缺同校協同教學師資	Lack of co-teaching teachers.	➤ Lack of co-teaching teachers.	Group 4



No.	請問您身為一個老師，還有哪些是在教授「海洋教育」這門課時，仍然缺乏的專業需求？	As a teacher, are there any other professional needs that I still lack when implementing "Marine Education"?	The sentence for codes	Sub group
22	海洋教育的配套課程，現行並無法一套標準課程，所以如果沒有受訓過的老師，除非本身有很大熱誠，否則光備課就要花許多心力。	There is no standard course for marine education currently, so if you don't have a trained teacher, unless you have a lot of enthusiasm, you will have to spend a lot of effort for preparing lessons.	<ul style="list-style-type: none"> <li>➤ There is no standard course for marine education currently.</li> <li>➤ Have to put a lot of effort into preparing lesson as an untrained teacher without enthusiasm.</li> </ul>	Group 3 Group 1
23	不同議題的引導示範	Guided demonstrations on different topics	<ul style="list-style-type: none"> <li>➤ Guided demonstrations on different topics.</li> </ul>	Group 2
24	須有教學團隊的組成，議題上較能掌握與實施	Must be organized a teaching team, and it is able to master and implementated ME topics	<ul style="list-style-type: none"> <li>➤ Must be organized a teaching team to master and implement ME topics.</li> </ul>	Group 4
25	海洋的範疇很廣	The scope of the marine is very wide	<ul style="list-style-type: none"> <li>➤ The scope of the marine is very wide.</li> </ul>	Group 1
26	海洋科學專業知識	Professional knowledge in Marine science	<ul style="list-style-type: none"> <li>➤ Professional knowledge in Marine science.</li> </ul>	Group 1
27	製作剪接教學影片	Editing tutorial videos	<ul style="list-style-type: none"> <li>➤ Editing tutorial videos.</li> </ul>	Group 2

No.	請問您身為一個老師，還有哪些是在教授「海洋教育」這門課時，仍然缺乏的專業需求？	As a teacher, are there any other professional needs that I still lack when implementing "Marine Education"?	The sentence for codes	Sub group
28	海洋教育 是一門跨領域的課程，需要具備的相關的知識關多包括天文、地理、物理化學 水文地質 人文 社會科學等等，唯有不斷的廣泛的吸收各種知識，才能提升教學的專業性	Marine education is a cross-disciplinary course. It need to be possessed and learned the related knowledge includes astronomy, geography, physical chemistry, hydrogeology, humanities and social sciences, etc to improve the teaching profession.	<ul style="list-style-type: none"> <li>➤ Marine education is a cross-disciplinary course.</li> <li>➤ It needs to be possessed and learned the related knowledge includes astronomy, geography, physical chemistry, hydrogeology, humanities, and social sciences, etc to improve the teaching profession.</li> </ul>	Group 3 Group 1
29	實際實地參與	Actual field participation	➤ Actual field participation.	Group 2
30	專業培訓	Professional Training	➤ Professional Training.	Group 2
31	相關海洋的法規知識	Knowledge of relevant marine regulations	➤ Knowledge of relevant marine regulations.	Group 1
32	海洋生物標本製作	Making Marine biological specimen	➤ Making Marine biological specimen.	Group 2
33	對相關知識的學習仍可以加強	The relevant knowledge can still be learned and strengthened	➤ The relevant knowledge can still be learned and strengthened.	Group 1
34	跨領域的海洋課程專業熟悉度	Professional familiarity with interdisciplinary marine courses	➤ Professional familiarity with interdisciplinary marine courses	Group 3
35	海洋科學與技術	Marine Science and Technology	➤ Marine Science and Technology.	Group 1
36	海洋科學的知識相當廣泛，在國小包班式的教師養成教育中，無法讓	The knowledge of marine science is quite extensive, and it is impossible to develop	➤ The knowledge of marine science is quite extensive.	Group 1 Group 1

	老師具備相關知識！	relevant knowledge in the elementary schools teacher training education!	➤ It is impossible to develop relevant knowledge in the elementary schools teacher training education.	
No.	請問您身為一個老師，還有哪些是在教授『海洋教育』這門課時，仍然缺乏的專業需求？	As a teacher, are there any other professional needs that I still lack when implementing "Marine Education"?	The sentence for codes	Sub group
37	目前無特殊需求	No special needs currently	No special needs currently.	
38	海洋文化	Marine culture	➤ Marine culture.	Group 1
39	更正確的專業知識	More accurate professional knowledge	➤ More accurate professional knowledge.	Group 1
40	(1)海洋休閒、(2)海洋文化、(3)海洋社會、(4)海洋科學與技術、(5)海洋永續與保育。	(1) Marine leisure, (2) Marine culture, (3) Marine society, (4) Marine science and technology, (5) Marine sustainability and conservation.	➤ (1) Marine leisure, (2) Marine culture, (3) Marine society, (4) Marine science and technology, (5) Marine sustainability and conservation.	Group 1
41	如藉由做活動學習海洋教育的課程設計	Such as Curriculum Design of Learning Marine Education By doing activities	➤ Curriculum Design of Learning Marine Education By doing activities.	Group 2
42	教學者間的交流。	Communication among teachers.	➤ Communication among teachers.	Group 4
43	法規	Regulations	➤ Regulations.	Group 1
44	課業中是否可加入實際現場的操作及經驗	Can I add the field operations and experience into the course	➤ Can I add the field operations and experience into the course.	Group 2
45	專業知識不夠全面	Professional knowledge is not comprehensive enough	➤ Professional knowledge is not comprehensive enough.	Group 1
46	無	None	None	-

No.	請問您身為一個老師，還有哪些是在教授『海洋教育』這門課時，仍然缺乏的專業需求？	As a teacher, are there any other professional needs that I still lack when implementing "Marine Education"?	The sentence for codes	Sub group
47	1 親海活動的諸多專業技術。我曾經學過潛水、獨木舟，了解每一門都是不容小覷的專業 2 海洋相關知識	1 Many professional skills of pro-sea activities. I have learned diving and canoeing, and I understand that each subject is a major that cannot be underestimated. 2 Marine related knowledge	<ul style="list-style-type: none"> <li>➤ Many professional skills of pro-sea activities.</li> <li>➤ Each subject has its own professional knowledge.</li> <li>➤ Marine related knowledge.</li> </ul>	Group 2 Group 1 Group 1
48	海洋相關文本閱讀，深化教學體驗。	Reading marine-related references deepen the teaching experience.	➤ Reading marine-related references deepen the teaching experience.	Group 2
49	海洋知識的發展與資訊更新	Development and information to update marine knowledge	➤ Development and information to update marine knowledge.	Group 1
50	海洋法規、地質地貌	Marine regulations, geology and geomorphology	➤ Marine regulations, geology and geomorphology.	Group 1
51	海洋文化、海洋社會、海洋人文與海洋歷史...	Marine culture, marine society, marine humanities and marine history...	➤ Marine culture, marine society, marine humanities and marine history.	Group 1

## Appendix 4 QCA Codes of this study

### Total Codes of Teachers' professional needs (63 codes)

1. The related marine education science knowledge of elementary schools is limited.
2. It can effective to be integrated into the MOE-mandated courses.
3. School support
4. Knowledge
5. Resources of five themes.
6. Insufficient marine knowledge has the need to deepen and broaden.
7. Insufficient time for studying and learning
8. Don't know how to effectively design organized and systematic content with marine education.
9. Not major in this area especially Marine Science
10. Related knowledge of seaweed
11. New marine knowledge
12. I am still not familiar with ME
13. Lack of the sense of big concepts
14. Cognition about the marine
15. Knowledge related in Marine
16. Data interpretation
17. Teaching supplementary materials
18. Activity design
19. Professional theory
20. The cause of the phenomenon
21. There is no standard course for marine education currently.
22. Have to put a lot of effort into preparing lesson as an untrained teacher without enthusiasm.
23. Guided demonstrations on different topics
24. Must be organized a teaching team to master and implement ME topics
25. Editing tutorial videos
26. Knowledge of relevant marine regulations
27. The relevant knowledge can still be learned and strengthened
28. Marine Science and Technology
29. The knowledge of marine science

- is quite extensive
30. It is impossible to develop relevant knowledge in the elementary schools teacher training education
  31. Marine culture
  32. (1) Marine leisure, (2) Marine culture, (3) Marine society, (4) Marine science and technology, (5) Marine sustainability and conservation.
  33. Reading marine-related references deepen the teaching experience.
  34. Development and information to update marine knowledge
  35. Marine regulations, geology and geomorphology
  36. Marine culture, marine society, marine humanities and marine
  37. Insufficient practical experience in marine recreation.
  38. Need a license
  39. More study places to provide teachers with professional upgrades
  40. More sharing of practical teaching experience
  41. The scope of the marine is very wide
  42. Professional knowledge in Marine science
  43. Actual field participation
  44. Making Marine biological specimen
  45. More accurate professional knowledge
  46. Curriculum Design of Learning Marine Education By doing activities
  47. Regulations
  48. Many professional skills of pro-sea activities
  49. Each subject has its own professional knowledge.
  50. Marine related knowledge
  51. Lack of co-teaching teachers
  52. Professional Training
  53. Practical knowledge
  54. It is an integrated course.
  55. Choose the familiar course to conduct.
  56. Have complete teaching materials and lesson plans as reference

- 57. Marine education is a  
cross-disciplinary course**
- 58. It needs to be possessed and  
learned the related knowledge  
includes astronomy, geography,  
physical chemistry, hydrogeology,  
humanities, and social sciences, etc  
to improve the teaching profession.**
- 59. Communication among teachers.**
- 60. Can I add the field operations and  
experience into the course**
- 61. Professional knowledge is not  
comprehensive enough**
- 62. No relevant experience**
- 63. Professional familiarity with  
interdisciplinary marine courses**

## **Group 1 Professional knowledge of ME (35 codes)**

- 1. The related marine education knowledge of elementary schools is limited**
- 2. Knowledge**
- 3. Resources of five themes**
- 4. Insufficient marine knowledge has the need to deepen and broaden.**
- 5. Not major in this area especially Marine Science**
- 6. Related knowledge of seaweed**
- 7. New marine knowledge**
- 8. I am still not familiar with ME**
- 9. Lack of the sense of big concepts**
- 10. Cognition about the marine**
- 11. Knowledge related in Marine science**
- 12. Data interpretation**
- 13. Teaching supplementary materials**
- 14. Activity design**
- 15. Professional theory**
- 16. The cause of the phenomenon**
- 17. Have to put a lot of effort into preparing lesson as an untrained teacher without enthusiasm**
- 18. Knowledge of relevant marine regulations**
- 19. The relevant knowledge can still be learned and strengthened**
- 20. Marine Science and Technology**
- 21. The knowledge of marine science is quite extensive**
- 22. It is impossible to develop relevant knowledge in the elementary schools teacher training education**
- 23. Marine culture**



- 24. (1) Marine leisure, (2) Marine culture, (3) Marine society, (4) Marine science and technology, (5) Marine sustainability and conservation**
- 25. Development and information to update marine knowledge**
- 26. Marine regulations, geology and geomorphology**
- 27. Marine culture, marine society, marine humanities and marine history**
- 28. The scope of the marine is very wide**
- 29. Professional knowledge in Marine science**
- 30. More accurate professional knowledge**
- 31. Regulations**
- 32. Each subject has its own professional knowledge**
- 33. Marine related knowledge**
- 34. It needs to be possessed and learned the related knowledge includes astronomy, geography, physical chemistry, hydrogeology, humanities, and social sciences, etc to improve the teaching profession**
- 35. Professional knowledge is not comprehensive enough**

## **Group 2 Sharing practical and experiences (16 codes)**

- 1. Guided demonstrations on different topics**
- 2. Reading marine-related references deepen the teaching experience**
- 3. Don't know how to effectively design organized and systematic content with marine education**
- 4. Editing tutorial videos**
- 5. Insufficient practical experience in marine recreation**
- 6. More study places to provide teachers with professional upgrades**
- 7. More sharing of practical teaching experience**
- 8. Actual field participation**
- 9. Making Marine biological specimen**
- 10. Curriculum Design of Learning Marine Education By doing activities**
- 11. Many professional skills of pro-sea activities**
- 12. Professional Training**
- 13. Practical knowledge**
- 14. Have complete teaching materials and lesson plans as reference**
- 15. Can I add the field operations and experience into the course**
- 16. No relevant experience**

### **Group 3 Difficulty in integrating ME course (6 codes)**

- 1. It can effective to be integrated into the MOE-mandated courses**
- 2. There is no standard course for marine education currently**
- 3. It is an integrated course**
- 4. Choose the familiar course to conduct**
- 5. Marine education is a cross-disciplinary course**
- 6. Professional familiarity with interdisciplinary marine courses**

#### **Group 4 School & colleagues administrative and teaching support (6 codes)**

- 1. School support**
- 2. Must be organized a teaching team to master and implement ME topics**
- 3. Insufficient time for studying and learning**
- 4. Need a license**
- 5. Lack of co-teaching teachers**
- 6. Communication among teachers**