

# BoK- STCW-TRB Triumvirate Course Mapping for Learning Outcome Matrix of BS Marine Engineering Program

Mao Tze M. Bayotas

<sup>1</sup> *Maritime Academy of Asia and the Pacific, Philippines*

\* *Corresponding author: maotze.bayotas@maap.edu.ph; Tel.: +639176239038.*

---

**Abstract:** The European Maritime Safety Agency (EMSA) has raised several deficiencies regarding the Philippines' maritime education and training over the years since 2006. The most notable of them include the non-spiral, non-holistic, and outdated approach to the curriculum being implemented. This led to the endangerment of the employment of Filipino seafarers aboard European vessels and the potential removal of the Philippines from the IMO whitelist. To address this looming problem, this study has developed a triumvirate mapping that uses the elements of the STCW, the Book of Knowledge (BoK) by IAMU, and the training record book (TRB) of Global Maritime Education and Training Association (GlobalMET). The resulting framework served as a guide in crafting the learning outcomes for a holistic, STCW-compliant, and practical approach. The methodology employed a qualitative design of exploratory nature wherein the STCW Table was cross-referenced and analyzed with the BoK and TRB. This resulted in a new framework containing a triumvirate map that will be essential to the curriculum developers in formulating a program that will be at par with the global standards with a three-pronged approach to cadet development, spiral learning, and competence acquisition as required by the STCW.

**Keywords:** course mapping; curriculum development; global maritime professional; maritime education and training; book of knowledge

---

## 1. Introduction

The European Maritime Safety Agency (EMSA) has already conducted a series of audits on maritime education and training (MET) here in the Philippines starting in 2006 (Andersen & Nielsen, 2013). Throughout the years, non-conformities and observations were listed, and most of the findings in recent years were centered on the delivery of education amongst Maritime Higher Education Institutions (MHEI). In the last meeting with the International Association of Maritime Universities (IAMU) and International Maritime Organization (IMO) delegates, it was pointed out that the major findings when it comes to MHEIs in the Philippines are the non-spiral, non-holistic, and obsolete education, and training (IAMU, 2020). These findings led to the brink of Filipino seafarers being banned from European Union (EU) ships, which will potentially wipe out 28,784 Filipino seafarers from employment (EMSA, 2019).

Currently, the Maritime Industry Authority (MARINA) and the Commission on Higher Education (CHED) are working to address the stated findings. One solution they have crafted is the introduction of the new curriculum under the Joint CHED-MARINA Memorandum Circular 01, series of 2022 (JCMMC 01 s. 2022). The new curriculum should be able to address the spiral learning approach being recommended by EMSA with the injection of emerging technologies. This new curriculum also inculcated the concepts and principles being presented from the Book of Knowledge (BoK) of IAMU, where not only cognitive faculties will be honed but also the psychomotor and affective faculties of the cadet as well. In addition, the competencies under Table III/2 and Table II/2 of the International Convention on Standards, Training, Certification, and Watchkeeping (STCW) were removed to focus more on the competencies of the operational level officers (CHED, 2022).

Despite these measures taken by CHED and MARINA, it was later found out during the last meeting with MHEIs all around the Philippines in September 2021 that there are still inadequacies. One, although the spiral education approach was much improved from the last curriculum, there are still flaws that can be observed, especially with the flow of the learning outcomes. Second, the complexity of the assessment of cadets based on cognitive, affective, and psychomotor faculties without the learning outcomes being holistically developed prior.

Lastly, compliance with the STCW Code when it comes to the knowledge, understanding, and proficiency (KUP) that can be accomplished in an approved shore facility was not taken into consideration (CHED & MARINA, 2021).

Through the years, the framework being used in the development of the curriculum in maritime higher education is based on the IMO Model Course 7.02 and 7.04. This IMO framework is based on the STCW Code, where learning outcomes are given for each KUP stated in the STCW Table. Then the IAMU released its BoK to guide member institutions in developing learning outcomes for a more holistic approach suitable for the tier of education being delivered. However, the use of the Book of Knowledge in crafting the maritime education curriculum is not yet widely practiced due to the difficulty of adopting the said framework with the IMO Model Course. The training record book (TRB) produced by different organizations also offers a potential framework on which the maritime curriculum can be based on. This way, cadets, as they go through with their program, can be able to attain the knowledge and skills required by the STCW convention while also being able to accomplish the tasks designated in their TRBs (Cunningham, 2015).

Therefore, a framework for the curriculum development of maritime higher education needs to be crafted to merge the matrix of the IMO Model Course, the BoK, and the TRB. This kind of framework will be beneficial to ensure the development of a holistic cadet that attains all the needed KUPs required by the convention. In the process, the training tasks indicated in the training record book that can be accomplished using shore facilities can already be ticked off, thus making the training onboard focused on the tasks that cannot be replicated on shore. This will ensure the compliance of the Philippines' MHEIs to the STCW and put an end to the Philippines' woe with the European Maritime Safety Agency.

This study aims to develop a triumvirate course mapping using the STCW, BoK by IAMU, and the training record book of the Global Maritime Education and Training Association (GlobalMET), which can be used as a matrix in the crafting of learning outcomes of the maritime curriculum under the BS Marine Engineering (BSMARE) program. To attain the overall objective of the study, there are sub-objectives that need to be accomplished along the way, the first is the development of the level of achievements matrix for the three learning domains, learning outcomes matrix, BoK course mapping, TRB course mapping, STCW course mapping and the cross-mapping of the aforementioned course maps.

## **2. Methods**

### *2.1 Research Design*

This research employed a qualitative research design specifically on the aspect of exploratory case-study framework where a new idea is generated from the existing facts, ideas, and frameworks. The data and information were gathered from the STCW Code, the BoK by IAMU, and the TRB developed by GlobalMET. A new framework and matrix were developed based on the analysis and cross-referencing of the different components of the three frameworks.

### *2.2 Level of Achievement Matrix- Intended Learning Outcome Matrix*

The first procedure was the development of the level of achievement matrix for Tier A, which is the undergraduate study for operational-level officers based on the IAMU Book of Knowledge. The focus areas were plotted with the different levels of achievement and the expected outcome per level. This produced three tables, with one each for cognitive, affective, and psychomotor domains. Once the level of achievement has been established, the intended learning outcomes per focus area for that level have been identified from the IAMU BoK (IAMU, 2019). This produced another framework showing the mapping of the different guides in the development of learning outcomes per focus area. Each domain, specifically cognitive, affective, and psychomotor, had one table each.

### *2.3 BoK Course Mapping, STCW Course Mapping, and TRB Course Mapping*

Afterward, the different intended learning outcomes determined were mapped against the courses being implemented by CHED-MARINA for their BSMARE programs. Each intended learning outcome was analyzed if such is relevant to a particular course. This will produce the BoK Course Mapping for each of the learning domains. The next step was the TRB Mapping of the different courses offered by CHED-MARINA. This cross-referenced the different tasks included in the TRB of GlobalMET to the different courses they are related to.

This involved a thorough analysis of the different tasks in the TRB. Before the development of the triumvirate mapping, the CHED-MARINA STCW Course Mapping was checked regarding the completeness of all KUPs, alignment, and compliance with the STCW Convention.

2.4 BoK-STCW-TRB Cross-Mapping and Analysis

Once the checking was completed and the lacking KUPs had already been addressed, the triumvirate mapping of the BoK-STCW-TRB was developed per course. This is a detailed and comprehensive table where for each course, the different intended learning outcomes from the BoK are considered together with the KUP stated in the STCW Code. TRB tasks that can be accomplished for that course and KUP are also included.

3. Results

The level of achievement was first determined in line with the latest memorandum released by CHED-MARINA under JCMC 01 s 2022. This new memorandum aims to produce graduates with the competence listed under the STCW Table A-III/1 and Table A-II/1. In reference to the BoK developed by IAMU, the level of achievement appropriate for the program outcomes stated is Tier A, with some elements of Tier B for the principle of mechanics and thermodynamics. Analyzing the program outcomes and the curriculum released by CHED-MARINA, a tier A-tier B hybrid will be mapped for the level of achievement according to BoK (IAMU, 2019).

3.1. Intended Learning Outcome Matrix Map

The level of achievement needed for the mental aspect of the cadets for Tier A-Tier B hybrid was mapped in accordance with the BoK. The level of learning based on Bloom’s Taxonomy is determined by each of the four major scopes of learner’s development, namely the foundational elements, academic elements, professional-technical elements, and the professional-soft elements. The BoK aims to develop a holistic approach to the learning of the cadets. Thus, the level of achievement is also determined for the affective and the psychomotor domain. A representative table is only shown, which is only a portion of the extensive table mapped out for the three domains of learning across the four focus areas with 28 sub-focus areas.

Table 1. Representative table of learning outcome matrix for the psychomotor domain.

Focus Areas	Perception (Awareness)	Set	Guided Response
<b>11. Technical Competencies as per International Requirements (STCW)</b>	<b>Identify</b> maritime actions that involve complex movement patterns and <b>choose</b> correct action(s) among various options to meet operational requirements of efficiency and safety as per international requirements	<b>Explain</b> the most professional, efficient, and safe way of performing practical motor tasks. <b>Prepare</b> optimally for commencing such tasks	<b>Respond</b> to and <b>follow</b> instructions regarding specific technical operations that require practical motor-skills

Once the level of achievement was properly and correctly determined, the intended learning outcomes for each domain were mapped out based on the BoK. Each sub-focus area under each of the different levels of learning has its own intended learning outcomes. Table 1 shows the mapped-out intended learning outcomes for the psychomotor domain as a representative sample due to the extensiveness of the original table. The same mapping was carried out for the cognitive and affective domains. Subsequently, a course mapping was performed between the determined intended learning outcomes against the set of courses provided in the JCMC 01 s 2022. The factors considered in the analysis of the mapping done were based on the course descriptions, program of study, and the program outcomes provided in the memorandum.

3.2. BoK-STCW-TRB Triumvirate Mapping

The next mapping and cross-referencing were the training record book tasks indicated in the GlobalMET TRB against the courses. The task listed in the TRB under each function and competency was compared with

the KUP and competency mapping of the course packages. The TRB tasks were mapped against the course under which the KUP was covered, as shown in Table 2. Table 2 again shows a representative table of the original table due to its extensiveness. An STCW-based course mapping was also performed to check the alignment of the course presented by CHED-MARINA to the competencies required by the convention. The course mapping also checked that all the required competencies were acquired by the cadets in compliance with the provisions of the STCW. The course packages of the JCMC are mapped and cross-referenced with Table A-III/1 of the STCW Code, as shown in Table 3. The TRB tasks course mapping, together with the BoK ILO course mapping and the STCW course mapping, are triumvirated to develop a more comprehensive and holistic framework that will serve as guidelines in formulating the learning outcomes of the courses of the BSMARE program. The three-axis framework will take into consideration the learning outcomes for the three domains stipulated in the BoK in consideration of the practicality of the tasks listed in the TRB in compliance with the STCW Convention. This will formulate a program that encompasses all three major frameworks of international maritime education and training.

Table 2. Representative table of TRB course mapping.

	MAINPROP	EWK1	EWK2	MAINT	COMPRE
<b>Function 1: Marine Engineering at the Operation Level</b>					
<b>Competence: Maintain a safe engineering watch</b>					
1.1: Taking over and accepting a watch and handing over a watch					
1.1.1 Demonstrate good understanding of procedure for handing over of engineering watch (a) at sea (b) in port					

Table 3. Representative table of STCW course mapping.

Competence	Code	Knowledge, Understanding, and Proficiency	MAINPROP	EWK1	EWK2	MAINT	COMPRE
<b>Function 1: Marine Engineering at the Operational Level</b>							
<b>Maintain a safe engineering watch</b>	<b>1.1.1</b>	<b>Thorough knowledge of principles to be observed in keeping a marine engineering watch including:</b>					
	<b>1.1.1.1</b>	Duties associated with taking over and accepting a watch					

Table 4. Triumvirate course mapping for auxiliary machinery.

BoK ILO	Basic Construction and Operation Principles of Various Pumps	Basic Construction and Operation Principles of Air Compressors	Basic Construction and Operation Principles of Heat Exchanger
<b>Cognitive Domain</b>			
Identify key mathematics information and recall equations related to academic and professional skills			
Explain the relevant mathematical principles			
<b>Affective Domain</b>			
Practice simple decision-making within the maritime workspace			
Initiate actions that demonstrate a proactive attitude in maritime professional practice			
<b>Psychomotor Domain</b>			
Explain the most professional, efficient, and safe way of performing practical motor tasks. Prepare optimally for commencing such tasks			

	Make a simple sketch of a centrifugal pump showing various components	Make a simple sketch of various positive displacement pumps onboard, showing various components	Make a simple sketch of an air compressor showing various components
--	---	---	--

As shown in Table 4, which is the sample triumvirate mapping developed for an auxiliary machinery course, the extensiveness of the table shows the three criteria on the x and y-axis. The intended learning outcomes for the three domains based on the BoK are listed in the leftmost column. The STCW KUPs that need to be attained are listed on the topmost row, with the appropriate TRB tasks in line at the bottom row. This three-axis triumvirate map serves as an effective guide in the formulation of much more effective and holistic learning outcomes for the different courses.

#### 4. Discussion

With this triumvirate course mapping being one of its kind and the foremost comprehensive framework in curriculum development, inculcating the concepts and foundations of the STCW, BoK, and TRB, there are only a few studies that were in correlation with the newly developed framework. To develop a globally competitive marine engineer in the modern world, professional skills are inadequate (Andersen & Nielsen, 2013). Soft skills and technical skills are becoming more and more critical requirements for a marine engineer in the 21<sup>st</sup> century. This is in line with the aim of the Global Maritime Professional (GMP) under the IAMU initiatives, wherein the two major focus areas are technical skills and soft skills, as indicated in the BoK. As seen in the developed course mapping, these focus areas are emphasized in the leftmost column with the specific learning outcomes for the different courses. This will enable the development of an appropriate program where professional skills are being honed together with technological and soft skills. At the recently held IAMU virtual conference in March 2020, the most important skill in the data revolution is soft skills, with technological skills coming in at number two (IAMU, 2020).

With the rise of cybersecurity in the maritime industry, together with the increasing maritime incidents on the part of the crew despite advancements in technology, a global maritime professional is increasingly in demand across the seven seas (Bauk & Ilcev, 2021). This emphasized the importance of using the BoK as guidelines in the formulation of the MET programs by the different administrations, especially those who are party to the STCW Convention. The TRB is also an essential part of the attainment of the needed competencies by future marine officers, which should also be updated with the changing times (GlobalMET, 2011). To bridge the gap between inadequate sea time and the limitations of opportunities encountered onboard ships, some of the tasks indicated in the TRB can be administered by institutions. This can fuel the development of maritime instruction and assessment considering the performance of some of the TRB tasks.

The Philippines' MET has made strides, but there is still a lot of room to grow (Cunningham, 2015). First is the upgrading of the level of learning from mostly remembering to analyzing and possibly creating, which can be boosted by using the framework as guidance. There are also issues regarding the alignment with the STCW Convention, with some of the KUPs left unaddressed. The approach in the delivery and the sequence of the courses are also not following the spiral approach, with some of the programs tackling advanced competence and topics prior to the fundamental ones. Lastly, the balance and the holistic approach in the determination of the psychomotor, affective, and cognitive development in each of the KUPs are also not well planned and implemented. The Philippines' MET also lags in the current technological trends and development with the introduction of emerging technologies and green shipping. With the three-pronged approach being used by the triumvirate, the learning outcomes and the program will become more updated, holistic, practical, and, most importantly, in compliance with the STCW Convention.

Assessing and ensuring the proficiency of the cadets after undergoing their respective maritime programs needs a lot to be desired as the current program is honing the development of professional skills only based on the STCW (Kalnina & Priedniks, 2016). In the age of information, this is insufficient to meet the demands of

modern shipping. Soft skills and technological skills are additional skills and competencies that need to be inculcated in maritime students. The STCW 2010 Manila Convention needs to be updated to accommodate the major changes that have happened over the last decade. Thus, to augment the gap posed by the outdated STCW, certain elements of the GMP and the BoK need to be assimilated into the current curriculum.

The current issue facing the MET is its evolution towards the information age (Manuel, 2017). With the advent of emerging technologies, it is recommended to upgrade and update the program. The triumvirate mapping exactly fits the framework they are seeking, where the three domains of learning are being honed across the critical focus areas. This is coupled with the strict adherence to the competencies stipulated in the STCW while offering flexibility in the delivery of the shipboard training program by allowing the maritime institutions to fill the gap for the TRB tasks that can be replicated onshore. This STCW-BoK-TRB mapping is a revolutionary guide, especially in the Philippines, to meet the standards set forth by the shipping companies and agencies such as EMSA. The comprehensive parameters to consider in crafting the learning outcomes leading to the revision of the curriculum are one step further in developing an updated, holistic, and effective maritime program that will ready future marine officers for the upcoming revolution in the shipping industry. This will make the curriculum development of the administration and the schools much easier and more effective.

## 5. Conclusion

Based on the data gathered, it is concluded that the process for the development of the triumvirate mapping starts with the determination of the level of achievements based on the BoK, followed by the mapping of the learning outcome matrix leading to the course mapping of the BoK, TRB and the STCW. Combining the three maps with careful analysis leads to the development of a new framework for the design and development of the program for BSMARE, which is the BoK-STCW-TRB triumvirate map. The completeness of the KUPs acquired was checked together with the appropriateness of the designation of the KUP. Careful analysis and interpretation of the guidelines of the BoK, together with the STCW Code and the TRB, is essential for the effectiveness of the developed framework.

For the next step of this research, verification of the developed framework and matrix should be done through an alpha test that will be conducted in the proponent's institution, which will be then verified by evaluation and audit of third parties. The result of the alpha test will then be compared with the result of the beta test that should be conducted in other institutions to ascertain the effectiveness of the newly developed framework and whether it is applicable to the Philippines' MET and to the international setting as well.

## Acknowledgments

The proponent would like to extend gratitude to the Maritime Academy of Asia and the Pacific for the opportunity and support, as well as to my family, friends, and fiancé for the love and memories.

## References

- [1] Andersen IM, Nielsen UD (2013) Educating maritime engineers for a globalized industry: bridging the gap between the industry and universities. <http://dx.doi.org/10.1115/IMECE2012-86011>
- [2] Bauk S, Ilcev SD (2021) The 1<sup>st</sup> International Conference on Maritime Education and Development: ICMED. Springer Nature
- [3] Commission on Higher Education (CHED), Maritime Industry Authority (MARINA) (2021) Minutes of the Meeting: CHED-MARINA Consultation Dialogue with MHEIs. CHED-MARINA, Philippines
- [4] Commission on Higher Education (CHED) (2022) Revised Policies, Standards and Guidelines for the Bachelor of Science in Marine Transportation and Bachelor of Science in Marine Engineering Programs (JCMMC 01 s. 2022). CHED-MARINA, Philippines
- [5] Cunningham SB (2015) The relevance of the maritime education and training at the secondary level
- [6] European Maritime Safety Agency (EMSA) (2019) EMSA Audit Report on the Philippines' Education and Training
- [7] Global Maritime Education and Training (GlobalMET) (2011) Engine Cadet Structured Shipboard Training Programme. GlobalMET
- [8] International Association of Maritime Universities (IAMU) (2019) Global Maritime Professional: Book of Knowledge
- [9] International Association of Maritime Universities (IAMU) (2020) Philippines' Maritime Education and Training

- [10] International Maritime Organization (IMO) (2017) STCW International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers. IMO
- [11] Kalnina R, Priedniks V (2016) Proficiency improvement method in maritime education. <http://dx.doi.org/10.1007/s13437-016-0112-x>
- [12] Manuel ME (2017) Vocational and academic approaches to maritime education and training (MET): Trends, challenges, and opportunities