



**PROJECT T-79 - NAUTICAL BSC PROGRAMS IN NORWAY & ABROAD –  
A STUDY DRAWING COMPARISON BETWEEN THE FOUR NORWEGIAN PROGRAMS  
AND EIGHT FOREIGN**



# MARKOM 2020 PROJECT T79 – REPORT

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## 1. Introduction

Markom2020 initiated this project in November 2016. Markom2020 is a government-funded project comprising the four Nautical Sciences Colleges/Universities in Norway. The objective of Markom2020 is to raise the overall quality of Nautical Science studies in Norway.

This project maps the various ways of structuring and modelling nautical science programs by means of indicators identifying the quality of selected Nautical Science study programs worldwide. A total of eight institutions were invited to take part in the mapping: Four in Europe, two in Asia and two in Americas. Data have also been collected from the four Norwegian Nautical Sciences Colleges/Universities in order to make a comparison.

The main objective of this mapping is to identify strategic areas of development in nautical BSc programs.

### 1.2. Background

Norway, characterized as a small, but wealthy country with an economy wide open to foreign competition, is dependent upon international market operations conditions for its exports of natural resources such as oil & gas, fish and hydropower generated energy and the rendering of minerals and metals. The service sector whose major contributors to the Norwegian economy are predominantly shipping services, management and operation, the same need to be internationally competitive.

Norwegian higher education and research consequently must educate people with the ability to take an active part in developing the international standards further. The legislation regulating higher education reflects this. The Universities and Colleges Act's three main aims are firstly to lay the foundation for the institutions to offer education at a high international level. Secondly, this to set standards for the research and artistic development, and the third aim is to communicate and teach in accordance with the principles of academic freedom.

Likewise, since Norwegian merchant marine officers compete internationally for their positions, the nation must provide them with an education that is appropriate for working in a highly international industry requiring personnel with relevant qualifications, competencies and skills. To maintain its position as a "world-leading maritime nation", the quality within the higher maritime education in Norway must be maintained and further developed<sup>1</sup>. Hitherto (2017), there has not been any systematic comparison between Norwegian and other international nautical study programs.

The Project Group wish to thank all those participating and hope they will find some relevance for their own program developments.

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<sup>1</sup> (Government's Maritime Strategy; Regjeringens Maritime Strategi, 2015 p 30-32)

## 2. Method

### 2.1. Selection

The eight international universities were selected based on the following criteria:

- The institution is located within a major maritime labour supplying nation.
- The institution is located within a highly industrialised shipping nation.
- The selection should represent a world-wide perspective.

### 2.2. Data collection

Four institutions were visited; two in Europe, one in Asia and one in North America. For these institutions, a project group member carried out the interviews based on an interview guide<sup>2</sup>. The remaining institutions reported their data in writing, based on the same interview guide. Before this report was finalised, it was distributed to the participating institutions for validation.

## 3. Quality indicators

The general problem when evaluating universities and colleges is to define and identify the institutional contribution to each candidate's competencies, skills and knowledge. First rate students, including candidates intellectually above average may learn whether they are enrolled in an institution with top learning environment, state of the art facilities and the most excellent teachers and professors, or not. Vice versa, the top institutions with regard to learning may lift under-average students up to a level where they achieve the needed competencies, skills and knowledge in order to perform well within a profession<sup>3</sup>.

The need to measure institutional performance is a direct consequence of international competition as indicated above, and it may also be inspiring for those measured because it gives information and trust; to the applicants and future candidates and their employers, to the funding governments / and or donators and also to the staff.

When developing quality indicators in order to contribute to such information these should<sup>4</sup>:

- Give precise and easily understandable information with respect to which degree goals are met
- Define and identify the institutional contribution with regard to achieving the goals.
- Exclude the various stakeholders (In particular the institutions, students and teaching staff) from the ability to manipulate the information given.

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<sup>2</sup> Appendix 2

<sup>3</sup> Centre for Economic Research at NTNU; SØF-rapport 01/16

<sup>4</sup> Norwegian research with further references; Centre for Economic Research at NTNU; SØF-rapport 05/16: Kvalitetsindikatorer i universitets- og høyskolesektoren (p.1).

This report does not evaluate the chosen maritime institutions, neither does it scrutinise the programs as such, as in the foregoing the report aims to identify strategic areas for further program development. Nevertheless, the foregoing criteria surely are a part of our understanding when identifying areas of importance for further program development.

### 3.1. Development of quality indicators

Firstly, the study asked for the institutions input and output, in the form of entry criteria and failure rate. Since high school exams are typically standard tests or exams used nation-wide, they are regarded as objective standards for measuring the cohort's level of competence before entering higher education. Consequently, they form a basis for evaluating the institutional contribution.<sup>5</sup> Research also states a direct causal link between the academic level of the entrants for college and universities and their college performance<sup>6</sup>. Failure and retention rates have two important aspects. High completion rates may inform potential applicants of a high quality institution where students have a good learning environment both physically and psychologically<sup>7</sup>, i.e. facilities, extracurricular activities and lecturers' classroom efforts do matter. On the other hand, low failure rates may also indicate a study program of lesser quality, i.e. if everyone completes why work hard?<sup>8</sup>

Secondly, the study asked for the structure and content of the nautical study program in relation to STCW related subjects, nautical/maritime subjects beyond the STCW requirements and complementary subjects e.g. science subjects.

Learning outcomes and status after completed study programs from the participating nautical colleges are all at BSc-degree level. However, as the way forward differs, it is possible to indicate if and why one is more successful than others. We chose the European Credit Transfer and Accumulation System (ECTS) and equivalent for the non-European universities in our study, as an instrument for comparison. These systems are standards with two aspects. One is to give the students credits for workload per subject and exams, consequently to make transfers between universities efficient. The other is to have transparency and standard for planning, delivery and evaluation of study programmes<sup>9</sup>.

<sup>5</sup> Norwegian research with further references; Centre for Economic Research at NTNU; SØF-rapport 03/13: Karakterbruk og kvalitet i høyere utdanning.

<sup>6</sup> In particular studies from the US and the link between Scholastic Aptitude Tests (SAT-score), ACT (American College Testing (ACT-score), High School grades, and academic success, a classical study here is Price, F.W. & Kim S.H. (1976) *The association of college performance with high School grades and college entrance test scores. Educational and Psychological Measurement*, 36 (4) 965-970.

As examples from recent years see Bettinger, E.P., Evans, B.J. & Pope D.G. (2013) *Improving college performance and retention the easy way: unpacking the ACT exam. American Economic Journal: Economic Policy* 5 (2), 26-52.

<sup>7</sup> Cfr. EU 2015 Dropout and Completion in Higher Education in Europe, which describes the complexity of study success as influenced by educational structures, national policies, financial incentives, institutional structures, teaching, curriculum design, student socioeconomic background and the interrelations between all these factors. The report has further references, such as American studies by Tinto, V. (2006) *Research and Practice of Student Retention: What Next? Journal of College Student Retention: Research, Theory and Practice* 8 (1): 1–19.

<sup>8</sup> We distinct between exam failures and drop out, on the other hand academic performance or lack of it will be an important factor for students considering withdrawing from their study programme, see as an example: Ulriksen, L. Madsen, L.M., Holmegaard, H.T. (2010) *What do we know about the explanations for drop out among young people from higher education programmes? Studies in Science Education* 46 (2): 209-244.

<sup>9</sup> Cfr. [https://ec.europa.eu/education/resources/european-credit-transfer-accumulation-system\\_en](https://ec.europa.eu/education/resources/european-credit-transfer-accumulation-system_en)

Thirdly, simulators and laboratories. Modern education of nautical students emphasises the use of simulation and laboratories in order to achieve the highest possible standards, before employment as a cadet and deck officer. Research within the field provides a wide range of evidences regarding the usefulness and effectiveness of simulator education/training<sup>10</sup>.

Fourthly, the academic/teaching staff. When educating for the nautical profession, people with industrial shipping experience as merchant officers and master mariners are preferred lecturers and teachers. This system of recruitment is acknowledged internationally as per the STCW-Code requirements, and it is implemented in national law for all our participating institutions. In addition to the required training, BSc- programs aim at providing students with the ability to read and understand complex theoretical subjects and to gain understanding of maritime research, thus giving students a platform also for further MSc and even PhD studies. The questionnaire therefore asks of operational competencies such as Certificates of Competence (CoC), academic competencies such as MSc and PhD combined with titles as professor, associate or lecturer.

The combination of operational and academic competencies is of particular interest. Therefore the report will identify the proportion of staff members with the highest level of professional standard (Master Mariner) combined with the highest academic standard (e.g. MSc or PhD)<sup>11</sup>

Fifthly, relevant research activities. When teaching complex theoretical subjects, it is a quality indicator that the institution's own teaching staff do carry out relevant research themselves.

Sixthly, final projects or bachelor thesis. Industrialized countries typically include academic learning goals for their BSc. nautical study programs. I.e. the curriculum not only contains subjects but also a final project or thesis.

### 3.2. Interview guide

An interview guide was compiled in order to ensure a homogenous data collection. The interview guide was based upon the selected quality indicators listed above.<sup>12</sup>

### 3.3. Limitations

Eight institutions from Asia, Europe and North-America were chosen, plus the four Norwegian institutions for higher education, thus the report and its findings is limited to these. However, these twelve institutions do represent traditional maritime nations and classic academic views regarding education and learning combined with what they themselves state as modern ways of training merchant officers at sea.

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<sup>10</sup> Please find relevant research listed in appendix 1.

<sup>11</sup> FOR-2017-02-07-137 Studietilsynsforskriften. FOR-2011-12-22-1523 Forskrift om kvalifikasjoner m.v. for sjøfolk.

<sup>12</sup> Appendix 2.

Some of the data reported in writing were insufficient for comparison, resulting in challenges during the data analyses.

#### 4. Institutions and interviews

The following chapter illustrates a summary of each of the institutions in the mapping. All of the institutions have been anonymised and are listed randomly.

##### Institution A

The University is a technical school with over 60-years' of tradition. In three faculties, Faculty of Navigation, Faculty of Marine Engineering, Faculty of Economics and Transport Engineering offering nine specializations, 4 000 students a year. The University's mission is to educate highly qualified maritime staff i.e. navigators and mechanics answering the needs of contemporary transport and fishing fleet as well as offshore staff prepared to implement computer software and systems for supporting transfer of information in the forwarding-logistics sector.

Faculty of Navigation:

- Institute of Marine Navigation
- Institute of Marine Traffic Engineering
- Institute of Marine Technologies
- Institute of Geoinformatics

The Nautical education is a 4 year programme with on board cadet training in semesters 6 and 7.

##### Institution B

The University has seven colleges - Maritime Science and Management, Life Sciences, Ocean Science and Resource, Engineering, Electrical Engineering and Computer Science, Ocean Law and policy, as well as Humanities and Social Sciences. These Colleges house a total of 22 undergraduate departments, 11 graduate institutes, 27 master programs and 20 doctorate program.

The University has undergone extensive change and is now recognized as one of the nation's most important centers of high learning and scholarship, especially in the marine sciences, maritime studies, and fisheries.

Responding to the changing needs of society and the widening interests of the students, the University is developing into a comprehensive institution with a unique maritime focus. The University aims to be an internationally known institution of higher education. Towards this end, their social sciences and liberal arts programs are developing as a core part of education at the University.

The University is rapidly becoming a provider of a positive learning environment and culture for intellectual and personal growth, with marine interests as a unique feature.

The college of Maritime Science and Management have 4 Departments:

- Department of Merchant Marine
- Department of Shipping and Transportation Management
- Department of Transportation Science
- Department of Marine Engineering

The Nautical education is a 4-year programme with operational cadet training at sea after the 1<sup>st</sup> and 2<sup>nd</sup> year, and in year 4. It is also possible to choose a fourth year of studying theory without sailing time, but these candidates need to arrange cadet sailing practice on their own after finalising.

### Institution C

This university has a tradition dating back to the beginning of the 19<sup>th</sup> Century as a single institute within mechanics and ship drafting. The nautical education dates back to the early 1890s. Today, teaching and research are provided by four faculties and a business school divided into departments, institutes and centres. The maritime education is an integral part of a large university with more than 25 000 full time students. It describes itself as being one of the nations' largest with a reputation for excellence.

Faculty of Engineering and Technology delivering 104 undergraduate and 31 post-graduate (MSc & PhD).

Divided into 1 maritime centre, 2 institutes and 6 departments.

Department of Maritime and Mechanical Engineering with 18 undergraduate and 7 post-graduate (MSc).

The maritime centre is responsible for delivering the maritime undergraduate and post-graduate (MSc) programs and research. In addition, various maritime courses taught to the industry.

The nautical education is a 4 year program including 12 months cadet period. Maritime programs and courses as follows:

- Diploma in Nautical Science Chief mate Unlimited / Master Unlimited (STCW II/2).
- BSc ( Hons) Nautical Science top-up degree,
- BSc (Hons) Nautical Science
- Foundation (FDSC) Marine Operations
- MSc. International Transport, trade and Logistics
- MSc. Marine and Offshore Engineering.
- MSc. Maritime operations Management.



- Management, 19 different courses from two days Ballast Water Management and other STCW- courses to a 4 weeks intensive Master / Chief Mate preparation course for their final oral exams.
- Simulation within BRM; CRM; Pilot training and general ship handling.
- Courses within fluid bulks, LNG, Chemical and oil cargoes.
- Various courses within workboat, fishing vessels and yachting below 3000gt.(OOW & Master).
- Various courses within Engine Room, GMDSS Training, Medical, Survival, Security, Firefighting.

### Institution D

The university was established in the late 1940s, but the nautical education dates back to the early 1870s. The maritime college with its maritime education programs is now an integral part of a large university (more than 25 000 full-time students).

Today teaching and research is carried out by colleges, science departments and research centres in a variety of campuses covering a huge variety of undergraduate, post-graduate and doctoral studies.

The maritime education programs are by volume the nation's highest and they describe themselves as the leading maritime educational institution.

The nautical education is a 4-year program, with a cadet period included as a third summer semester of three months.

### Institution E

The university have in all 12 undergraduate colleges of which one maritime engineering and one marine transportation.

The nautical education is 3-year program and covers the STCW requirements for holders of Nautical Certificate of Competence at management level.

### Institution F

The maritime education is an integrated part of a medium sized university (less than 25 000 full time students). Teaching and research are carried out by departments. The departments are led by a Head of department, and are made up of research groups and divisions.

The nautical education is a 4 year program including a 12 months cadet period.

#### Maritime Programs and courses offered

- 1-year officer program for small vessels. Practical experience needed.
- BSc. Maritime logistics
- BSc Marine Engineer
- BSc Nautical Science
- MSc Maritime Management
- MSc. Naval Architecture and Ocean engineering
- MOOC – master control in Supply Chain management and Logistics (general not particularly maritime).
- MOOC – Supply Chain and Logistics system design (general not particularly maritime).

For training courses, the Simulation Centre is used for training aspiring marine officers in advanced operations, including preventing and mitigating the consequences of accidents at sea. The simulators are also used in the training of professional active marine officers.

#### Institution G

The university has more than 18,500 students and 5,200 faculty and staff spread across four campuses. The following programs are offered at its marine campus:

##### Diplomas of technology

- Marine Engineering
- Marine Engineering Systems Design
- Marine Environmental Technology
- Nautical Science
- Naval Architecture

##### Joint Diploma of Technology/Bachelor of Technology

- Food Technology
- Ocean Mapping
- Underwater Vehicles

Bachelor online maritime studies. In addition master programs within marine subjects.

The nautical education is a 4-year program including a 12-months cadet period. The program covers the requirements of an operational CoC. The On board training takes place in the summer between the first and second year and the whole third year of the program.

#### Institution H

The University College is a small institution with a strong maritime portfolio, including nautical science, maritime business and maritime technology.

The institution has of four faculties; Maritime Studies Social welfare and health, Technology & Business Studies

The University College has a 160 year history and is the oldest existing higher education institution in the region. The maritime faculty campus is located in the heart of a maritime environment. The maritime educations has modern laboratories, covering essential maritime topics and simulator training.

The maritime faculty has about 400 students, who can engage with all aspects of the maritime sciences, such as nautical science, maritime technology, shipping management, maritime business, logistics and shipbuilding as well as the areas environment and ocean engineering. For the maritime students it is possible to continue their studies towards a master's degree.

The nautical science program lasts four years, covering STCW requirements for CoC at management level and with seagoing service included in the first and sixth semester.

#### 4.1. Entry criteria and results.

All the institutions in this survey require a completed high school / upper secondary education for matriculation. However, there are differences with regard to specific higher educational requirements for entering BSc. programs in nautical science.

Five of the total 12 universities, namely A, C, D, F and Nor1, have particular requirements of mathematics and typically emphasize logarithms, potencies, real exponents and polynomial factorization. In physics, specific mathematical methods are used to explain the movement and force, energy and energy resources, together with insight into climate conditions. This is similar to programs within technology and engineering. Three of the four Norwegian institutions offering higher education in nautical science lifted such requirements in 2007. Chapter 5 discusses the pros and cons of additional entry criteria.

Three of these five institutions, namely. C, D and F, also require proficiency in English language for matriculation. The STCW Code requires<sup>13</sup> that all nautical education programs maintain a certain level of proficiency in written and spoken English. Since this is an operational skill, the particular teaching and training of the English language forms a part of any modern maritime college. However, the level of proficiency reached by the students may be influenced by their entry level. The nine other institutions have no such requirement. Interestingly, because errors in communication are generally a contributory factor in any (operational) accident onshore as well as offshore. One should think that adding multilingual layers of complexity increases the risks involved. Thus, requiring a level of proficiency and general understanding of English language as matriculation for future officers makes sense. This would make it easier to understand and learn that maritime English and its particular demand for proficiency are not the same. Maritime Accident investigating reports seems to verify

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<sup>13</sup> Cfr. STCW-Code mandatory requirements in Part A table A-II/1.

that lack of maritime English proficiency is a concern in a number of cases every year<sup>14</sup>. We discuss this further in Chapter 5.

Two institutions, D and E, require a particular aptitude test and another two, A and B, have national admission exams. The effect of such requirements would primarily be to recruit only those with or above average intellectual performance. In addition, such measures could be used to range candidates when competition is hard; not only do national upper secondary exam papers count, but also these national tests contribute to securing an objective measurement.

Generally the various entry criteria, even though they represent differences in tradition and entry competition, could be characterized as adequate for recruiting qualified candidates. We advocate a discussion of whether such adequacy is sufficient to recruit those who not only have the personal ability to develop navigational skills but also the personality and drive to become future top officers. Because of the risks involved when operating ships and noting that statistics from Nordic marine underwriters show that 41 % of hull accidents and 39% of total claims' costs are caused by navigational involvement and errors,<sup>15</sup> there is a considerable responsibility resting on the educators of navigators. Having stated that, we must also recognize that both the Nordic insurers and the global insurance market note a stable trend of reduced frequency of total losses and claims in general<sup>16</sup>. In other words, one may argue that education and practice in general seem to have handled their part of risk management.

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<sup>14</sup> Cfr. [www.gov.uk/maib-reports](http://www.gov.uk/maib-reports) and [www.martel.pro](http://www.martel.pro) indicate that as much as 50% of accidents caused by human error have their root causes in poor communication.

<sup>15</sup> Cfr. Cefor annual report 2016 p. 24 adding collision, contact and grounding. [www.cefor.no](http://www.cefor.no)

<sup>16</sup> Op. Cit.

**Table 1. Entry criteria**

Institution	General requirements Successfully completed upper secondary / high school.	Vocational (y-vei)*	Specific Requirements	Admission exams/ tests	Aptitude test Yes / No	Remarks Practical exper. Needed Yes/No
A	YES	N/A	Min level 4 EQF: Math, Physics, Chemistry	Matriculation exam		
B	YES	Yes		YES National	No	Accept only top 30%
C	YES, including 3 A level subjects.		1) Proficiency in English. 2) Mixture of B & C grades to enter BSc. 3) Grade B level in Math	No	No	No
D	YES		Two letters of recommendation, one from an academic source. Recommended subj.: 4 yrs. of English & social studies. 3 yrs. of mathematics & science, chemistry and physics		Yes	No
E	YES		Math. English, Science. Appt. test incl. Personality & Intellect		Yes	
F	YES		Proficiency in English. <u>Mathematics</u> incl. logarithms, potencies, real exponents, etc. <u>Physics</u> 100 hours. Physics and math-methods. Movement and force, energy and resources, etc.	No	No	No, but additional sea-time required after final exams to obtain authorisation
G	YES	N/A				
H	YES					No
Nor 1	YES	N/A	Math. R1+R2 and Physics Pre-course may excl. specific requirements	No	N/A	No
Nor 2	YES	Yes	Pre-course in math. Available	No	N/A	No.
Nor 3	YES	Yes	Pre-course in math. Available			No.
Nor 4	YES	N/A	Pre-course in math. Available	No	No	No

**Table 2. Admission and Failure Rates**

Institution	Admission rate Qualified applicants 1 <sup>st</sup> Pri. applicants Average last 3-5 years	Acceptance rate *** Average last 3-5 years	Number of students enrolled in program ***** Average 3-5 years	Failure rate all subjects (student's retention rate) Average last 3-5 years
<b>A*** 4 year program</b>	87,5% (320 appl. 280 enrolled)	NA	640	20,3%
<b>B 4 year pr.</b>	14,1%	NA	470	NA
<b>C** 4 year pr.</b>	NA	NA	12	NA
<b>D*** 4 year pr.</b>	66% (266 appl. 174 enrolled)	NA	505	5,9 % (87%)
<b>E 3 year pr.</b>	NA	NA	144	18,5%
<b>F*** 4 year pr.</b>	15% (639 appl. 98 enrolled)	54% (181offers 98 enrolled)	251	19%
<b>G 4 year pr.</b>	NA	NA	192	30% (70%)
<b>H 3 year pr.</b>	NA		90	3,3% - 5,5% (94,5% - 97,7%)
<b>Nor1*** 3 year pr.</b>	100% (14appl. 14 offers)	77% (14 offers 11 enrolled)	55	17% (79%)****
<b>Nor2*** 3 year pr.</b>	40% (148 appl. 59 offers)	68% (59 offers 40 enrolled)	119	7,4% (93%)****
<b>Nor3*** 3 year pr.</b>	60% (107appl. 62 offers)	68% (62offers 42 enrolled)	143	9,9% (88%)****
<b>Nor4*** 3 year pr.</b>	63% (79 appl. 50 offers)	62% (50 offers 31 enrolled)	115	11% (86%)****

Institutions marked with \* have not provided data for all three years or more.

Institutions marked with \*\* do not operate with admission rates due to low number of enrolled students.

Institutions marked with \*\*\* provided data for 1<sup>st</sup>. priority applicants. There is no data regarding numbers of offers for institutions A, D and F.

Institutions in Norway\*\*\*\* register ECTS points produced as per student's individual plan and percentage of how many who fulfil their own plan. Thus, we use this as an indication of retention rate.

\*\*\*\*\*Program enrolment includes students in all 3 or 4 years.

**Comments table 2.**

Admission rates vary widely among the nine institutions that provided data, cfr. Table 2 below. Total applicants are from 14 (Nor 1) to 639 and 3-5 year average admission rates varies from 14% to 87.5%. This reflects the countries' different ways of reporting and we therefore considered that for some of the institutions the total number of applicants included all formally qualified, but not necessarily selecting this program as their first choice.

Applicants who do prioritize the nautical study program first give a variation of admission and acceptance rates from 40% to 87.5% among the institutions. The distinction here between admission and acceptance rate is important, because two institutions, A and D, show real competition in their admission rates while the others do not.

As an example, D's admission rate of 66% is a result of real competition, while in Norway, even though admission rates vary from 40% to 100% all four institutions send out more offers than first priority candidates were willing to accept. These four Norwegian institutions sent 185 offers, but only 124 first priority candidates accepted. Thus, the competition seems to be lower than candidates seeking admission to A and D. To verify this assumption one must take a closer look at the respective intake levels. However, it is hardly any surprise that the more first priority applicants per seat in the classroom, the tougher the competition gets.

With regard to final results, we find that the failure rate when counting all exams in the program varies from 7 % to 20 % and is highest for the institution with the highest admission rate (ref. institution A). This, however, is not an indication of a clear causal connection between failing exams and admitting a higher number of applicants. Norwegian research indicates that as grading in higher education is not an objective result given equally among or even within institutions, low failure rates may just as well be a result of low intake levels combined with a praxis or culture of positive grading.<sup>17</sup> Similarly, high failure rates may very well be the result of a strong emphasis on quality.

Failing your exam is one thing, but to drop out of the program is quite another. Therefore, it is important to measure progression by a retention rate equalling the percentage of first time, first year students who continue the following year, and students who do not finalize their studies after a period of time. One example is to measure students that complete within 150% of the published time for the program, i.e. 6 years after matriculation, those are not considered failing. A particular problem when comparing failure rates globally is the differences in policy from one nation to another. In Norway, students may complete their BSc a number of years after the original study plan, there are few legal limitations,<sup>18,19</sup> while other nations may have stricter regulations with regard to progression. The Norwegian retention rate therefore only shows percentage rates of students following their own study plan; a plan that may differ from the formal program plan.

<sup>17</sup> Centre for Economic Research at NTNU; SØF-report 03/13: Grades and quality in higher education. One main point here is that it is naive to think that many of those with lower grades from high school, but qualified to study at local colleges, will perform better than the average or top students at the nation's elite universities and colleges.

<sup>18</sup> Cfr. Universities and Colleges Act Section § 3-2 Study Plan. cfr. NOU 2003:25. The study plan is not a legally binding document.

<sup>19</sup> FOR-2011-12-22-1523 Forskrift om kvalifikasjoner m.v. for sjøfolk.

#### 4.2. Structure and content of the nautical curriculum

There are two main models for structuring the curriculum of nautical BSc-programs containing the competencies in the STCW Code, or a combination of the two:

- 1) Cover the competencies at the operational level, STCW A-II/1, subsequently the competencies at the management level, STCW A-II/2. The so-called “*sandwich model*”.
- 2) Cover both the operational and management level within the same subjects e.g. Meteorology. The so-called “*integrated model*”.
- 3) A combination of items 2.1 and 2.2 above.
- 4) Approved seagoing service in addition to one of the above models.

Mapping the variation among the twelve, we find the following:

**Table 3. Curriculum Structure**

Institution	Model (see above)	Compulsory STCW subjects (ECTS or Equivalent)	Complementary subjects (ECTS or equivalent)	Nautical / maritime beyond STCW requirements (ECTS or equivalent)	Thesis (ECTS or equivalent)	Sum ECTS or equivalent
A	2+4 (60ECTS)	101	49	15	15	240
B 1*	2+4 (60 ECTS)	97	33	50		240
B2 *	2	97	33	115		245
C	1+4 (60 ECTS)	105	20	35	20	240
D	2+4 (60 ECTS)	120	48	72	n/a	240
E	2	81	95***	0	N/A	176
F ****	2+4 (60 ECTS)	127,5	22,5	15	15	240
G **	1 + 4 (60 ECTS)	133	47	0	None	240
H	2+4 (60 ECTS)	103	30	35	12	240
Nor1	2	100	50		20	170 (Note: according to the study plan from 2017 a new elective subject have been introduced, but no ECTS listed)
Nor2	2	112,5	35	17,5	15	180
Nor3	2	105	30	30	15	180
Nor4	2	127,5	15	22,5	15	180

\*B1 60 ECTS sea practice included in 4 year program.

\*B2 sea practice replaced with theoretical studies in year 4 – Either nautical or shipping in depth studies.

\*\*G program covers only operational level

\*\*\*E including 90 ECTS elective subjects non-nautical

\*\*\*\* F Compulsory STCW subjects (127,5) include some complementary work, i.e. at operational level and report writing.



**Comments table 3**

We find that six out of eight foreign institutions prefer an integrated model teaching the students operational and management competence without any distinct difference. In addition to this choice of model, we have the choice of integrating seagoing practice as a part of the Nautical BSc-program. Five of the eight foreign institutions have chosen to integrate seagoing practice and this practice leads to a Certificate of Competence. Surely, the first year of studying starts with basics, but as institution F says in our interview: *“First period at sea is at the start of second semester. When the students return, working with complex tasks on the simulator makes so much more sense, and their ability to reflect upon situations and their acknowledgement of the navigational skills required have increased”*.

This integration is regarded as a way of stimulating a high level of understanding and when combined with written and verbal analysis / discussions, the students achieve academic standards as well as the practical skills. We may add that this combination of practice and simulation is a form of problem-based learning (PBL) and a well-proven structure for professional education<sup>20</sup>.

Regarding the integration between operational and management level, University C says that: *“we used to be more integrated in the past and now concentrate on a sandwich structure of their program”*. This is interesting because this shift or stronger emphasis on step-by-step learning comes from an institution with a long academic tradition. It could be said that this merely indicates that more than one model may achieve the same goals, and eventually it is up to the teaching staff and their personal preferences.

The four Norwegian institutions do not include approved seagoing service in their curriculum, thus they have no responsibility or formal exams and proven skills related to the cadet period. The certification is purely a matter for the Norwegian Maritime Authority. In general, this Norwegian tradition has until now been regarded as an efficient and workable system serving the ship owners/managers well. However, we find this model presents particular challenges that are discussed. Chapter five that covers how institutions manage their cohorts and how they could measure their institutional performance as educators.

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<sup>20</sup> Strømsø, H.I., Lycke, K.H., Lauvås, P.(2016). *Når Læring er det Viktigste*. Cappelen Damm AS

#### 4.2.1. Study plan

Study plans for nautical BSc degrees internationally will typically be organised with subjects covering STCW requirements and practical on-board training as compulsory basis, supplemented with some compulsory courses of particular importance for future deck officers and their ship owners / managers. In addition elective courses are offered in order to broaden the students' knowledge. Some institutions also include a final thesis.

Norwegian study plans differ from those of international institutions because practical on board training is not included in the curriculum.

#### 4.2.2. Specialization beyond STCW requirements

When defining quality indicators we took particular interest in asking whether and to what extent the institutions require subjects beyond STCW requirements. Most institutions seem to favour typical subjects categorized as follows: advanced management and operation of the ship /cargo; commercial management of ships; legal rules and regulations of ships and shipping industry. These categories cover the central technical, commercial and legal aspects of shipping with subjects such as:

- Bridge Operation
- Bridge Resource Management
- Navigation and navigation technology
- Environmental challenges
- Maritime Economics
- Chartering / Maritime Law
- Marine Insurance.

Cfr. Institutions B, C, D & F and Nor 1-4.

In addition, individual institutions offer subjects in accordance with their tradition and competence; for instance a classic academic subject like English expository writing and analytic reading combined with technical writing of reports and research work, cfr. Institution D or sustainable shipping from an environmental perspective, cfr. Institution F. This enables the institutions to brand their own profile and hence maintain market position.

#### 4.2.3. Access to updated nautical publications, conventions and codes

All twelve institutions seem to grant students access to a university library with literature on the syllabus, IMO publications, on-line access and Sea-web Ports, IMO VEGA, Knovel, Access Engineering, Science on-line. In short, the institutions in our study do not have any problems with updated literature well above the STCW requirements.

### 4.3. Simulators and laboratories

Modern nautical education seems almost unthinkable without access to simulators. This seems verified by our study and there are two major suppliers, namely Kongsberg Maritime AS, Norway and Transas Marine Ltd., Ireland.

#### 4.3.1. Navigational simulators

##### *Full mission and part task simulators*

All twelve institutions report in general to have updated and modern full mission simulators from either Kongsberg or Transas. For part task simulators the situation is more or less the same.

#### 4.3.2. Other types of simulators and laboratories

There are a number of simulators in use; for liquid cargo handling such as LNG/ LPG, for dry cargo or stability calculation, container storage and logistics, weather routing, machinery and connection with bridge, GMDSS and Dynamic Positioning (DP).

Table 4. Simulator training

Institution	Number of semesters with STCW required simulator training	Simulator training beyond STCW requirements Type & Semesters	No. of students per full mission simulator	Total hrs. on navigational simulators	Total hrs. on other types of simulators or laboratories
<b>A</b>	<u>2 semesters:</u> 5 <sup>th</sup> semester ARPA and GMDSS simulator. 8 <sup>th</sup> semester ECDIS simulator.	Ship survey, Manoeuvring, Liquid Cargo handling i.e. Oil Tankers and Gas Carriers.	3	63	354, including laboratory training
<b>B</b>	<u>2 semesters:</u> 5 <sup>th</sup> sem. Navigational simulator 6 <sup>th</sup> semester, ECDIS, ARPA and GMDSS	Ship handling, Liquid Cargo handling in elective subjects	4, only used in elective subjects	142	Depends on subjects elected
<b>C</b>	<u>6 semesters</u>	Yes	1-2	204	80
<b>D</b>	<u>5 semesters</u>	Yes	2-3	224	84
<b>E</b>	<u>4 semesters</u> 4 <sup>th</sup> sem. Radar/ARPA 5 <sup>th</sup> sem. GMDSS 5 <sup>th</sup> & 6 <sup>th</sup> sem. ECDIS	Ship handling, Liquid Cargo handling	5	189	198
<b>F</b>	<u>8 semesters</u>	Yes	2-3	216	92
<b>G</b>	2 plus 1 3 <sup>rd</sup> & 4 <sup>th</sup> sem. and between semesters the 2 <sup>nd</sup> and 4 <sup>th</sup> year		4	157	
<b>H</b>	<u>4 semesters</u> 4 <sup>th</sup> sem. Radar/ARPA 5 <sup>th</sup> sem. ECDIS 5 <sup>th</sup> sem. GMDSS 7 <sup>th</sup> sem. LCHS and ERS (voluntary) 8 <sup>th</sup> sem. Ship handling/ BTM. Offshore Navig.	Not identified in interview. Labs; radio (GMDSS), Navigational instruments, DP, etc.	3	200	120
<b>Nor 1</b>	6 semesters	Not identified in interview. Labs; radio (GMDSS), Navigational instruments, Ship-hydrostatic lab,	2 -3	216	100 Have available research vessel 2-3 days during the study.
<b>Nor 2</b>	All six semesters have simulator training	Not identified in interview. Labs; radio (GMDSS), Navigational instruments, DP, Offshore ship handling.	2	336	104
<b>Nor 3</b>	4 semesters	Not identified in interview. Labs; radio (GMDSS), Navigational instruments, DP, etc.	2 (some 1). For BRM: 3 per bridge + 2-3 observing.	222	112
<b>Nor 4</b>	4 semesters	Not identified in interview. Use of simulators and labs such as radio (GMDSS), Navigational instruments, DP, etc.	2-4	226	124

#### Comments table 4

The table is self-explanatory but two aspects deserve comment. Firstly, there is a variation with regard to scheduling simulator training in the program. With the exception of institution F the foreign institution seems to start with such training at a later stage than in Norway, where the start is at the beginning of the study program and is followed up through the whole program as an integrated part.

#### 4.3.3. Number of students on each bridge during exercises in the full mission simulator

2-4 students seems to be preferred. Thus indicating an emphasis on the typical situation for bridge teams and the role of OOW<sup>21</sup> on merchant ships.

One institution, C, starts with two and then only one student per bridge for their final part of the cadet program, except for exercise with larger teams. This allows the education to concentrate particularly and fully on the role as an officer of the watch with single responsibility for navigation without compromising the modern understanding of teamwork.

One institution, E, allows five students per bridge.

#### 4.3.4. Number of hours on the navigational simulators for each semester per student

There is a wide variation between chosen semesters and total hours in all; from 63 hours (institution A) to 334 hours (institution Nor2) and C, D, F, H and Nor 1 and 3 have 200 hours or more, cfr. Table 4. Please note that one must evaluate this in connection with other simulator and laboratory training as mentioned below.

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<sup>21</sup> OOW – Officer Of the Watch

#### 4.3.5. Number of hours on other types of simulators and laboratories

Again, a huge variety-ranging from 354 hours (institution A) to 80 hours (institution C). C, D, F, H and Nor 1-4 with more than 200 hours on navigational simulators have 80 to 120 hours on other types of simulators and laboratories.

Institution E have an interesting model with a balance of 189 and 198 hours on navigational and other types of simulators respectively.

Only institution F uses all 8 semesters to teach compulsory STCW requirements; an observation here is that their integrated model seems taken to its limits by maturing their students within the core element of the navigational skill and knowledge all through the program. However, the difference with institution C using 6 semesters and only 1-2 students or D and Nor1-2 with 5 and 6 semesters respectively but in total more hours, may not be noticeable or as viewed significant. Nor2 seem to emphasize simulator training giving their students 103 hours more than the average of compulsory simulator training.

#### 4.4. Academic/teaching staff

The maritime profession requires Certificates of Competency (CoC) for a number of positions on board, and the STCW-Code makes a distinction between CoC at operational (Op) and management (Man) levels respectively. The latter evidencing competency as a master mariner<sup>22</sup>.

**Table 5 Academic / teaching Staff**

Competencies	Institutions											
	A	B	C	D	E	F	G	H	Nor1	Nor2	Nor3	Nor4
Man CoC	19	2	6	19	16	22	10	10	3	5	5 + 1 (part time)	4
Op CoC	13	2	3	7	9	1					1	2
Man CoC + PhD	19	3	2			2			1	1	1	
Man CoC + MSc	18	8	2	15		11		2	2	1	2	2
Op CoC + PhD	5	2	-	1		1			1		0,5	
Op CoC + MSc	8		-	7		-					-	4
PhD	30	7	26	31		10		6	3	1	4	2
MSc	7		3			12	2	6	1		1	5
Valid CoC* required	No	No	Yes	Yes	NA	No	Yes	No	No	No	No	No
Number of research articles recently published **	100	60	31	7	0	11	N/A	6	18	9	15	28

\* Whether it is required of them or not, some holders of CoC nevertheless prefer to keep their certificates updated.

<sup>22</sup> Or Chief Engineer – not directly relevant for our study of nautical education.

\*\* This is a list of reported research from the last two years by the institute or department etc. responsible for the nautical BSc-program – peer reviewed in journals.

### Comments table 5

To educate professionals efficiently requires experienced staff. This concept of master teaching student, is shared by institutions worldwide and in a vast range of professions.

Institutions educating nautical professionals at BSc level share the same challenge, as other professions do, of academic standards with regard to recruiting and developing a staff of lecturers and professors combining experiential competence with academic degrees. The challenge is twofold and is about time and money. Firstly, it takes time to develop skills and formally acknowledged competency from the profession (CoC at management level) as well as from the academic institutions (MSc and PhD-grade and/or Status as professor). Secondly, recruiting top- level professionals is difficult. We may ask if the right incentives are developed. Today, institutions recruit holders of CoC at management level with an income rewarding them for their efforts involved in starting over again as a lecturer or instructor and maybe to study for MSc and PhD at lower wages. Combining this with a strong university culture emphasising academic performance over practical experience, one may also ask if any of the top- level professionals would actually accept. This way, the insufficient governmental financing of the nautical science education in Norway has direct impact on the quality of the education.

Seven of the twelve institutions in our study have at least one staff members holding both a CoC at management level and a PhD degree. Institution A is remarkable with a total of 54 staff members holding PhD's connected to their nautical program, including 19 staff members having management CoC and 5 holding a CoC at operational level and a PhD. None of the other institutions have similar capacities.

We may discuss the causal connection between a staff combining both levels of competencies and a thorough nautical education:

Firstly to what extent does a recognized STCW institution need to have a staff combining these competencies? The STCW- convention's formal requirement of achieving an adequate level of STCW proficiency (i.e. CoC at management level), is that those conducting in-service training of personnel qualifying for STCW-Certification shall "*be qualified in the task for which training is being conducted*",<sup>23</sup> and with respect to assessment of competence "*have an appropriate level of knowledge and understanding of the competence*"<sup>24</sup>. Thus, a recognized STCW-institution does not need to employ a staff including PhD degrees and competencies at levels of professors.

Secondly, modern industrial societies and their universities, however, do not seem to accept this standard as adequate for their BSc. program in nautical science. In addition, a typical requirement in western tradition is to give the students the necessary level of academic competencies and demand

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<sup>23</sup> Cfr. STCW Code Section A-I/6 4.2

<sup>24</sup> Cfr. STCW Code Section A-I/6 6.1

for critical thinking, i.e. the ability to recognise assumptions, deduce logically and interpret the evaluation of arguments<sup>25</sup>. We emphasise that there is no contradiction here; STCW does not exclude the academic competencies, but its focus is of a practical nature – after all, it regulates minimum requirements of proficiency for seafarers world-wide, while universities by nature shall be concerned with classical academic skills, new ideas, research and knowledge.

A BSc-degree in nautical science will in turn encourage some students to take further education at MSc. or even PhD levels, and later to be recruited as teachers and become professors. All in all, we understand this to be the best way of managing the development of professions. One particular concern is the robustness of these academic environments; in order to manage and deliver competencies from one generation to another each core subject of the nautical BSc education can only survive within the specific institution if there is a handover at some point. Ideally, in order to increase a subject's redundancy one may say that each subject should be managed by two staff members.

We define the robustness of an institution as to the ratio between the number of teacher's vs students and the ratio between total number of staff with a combination of management CoC and MSc/PhD. The above can also be related to the production of students and relevant publications. Looking closer at each institution's robustness, we generally find that the foreign institutions are more robust than the Norwegian ones.

Below (table 6) we have calculated the ratio between the number of teacher's vs students and the ratio between total number of staff with a combination of management CoC and MSc/PhD. Institution A and D are chosen as they represent the largest and second largest with respect to enrolled students, and Nor 1-4 are seen together in order to have comparable number of enrolled students

**Table 6 Ratio staff members / enrolled students**

Competencies	Institutions		
	A	D	Nor 1-4 Ratio in total
PhD Total	0,08	0,06	0,03
Man CoC + PhD/MSc	0,06	0,03	0,02

### **Comments table 6**

Comparing the Norwegian institutions with institution A we find that the combined ratio is only one third both regarding PhD total and Man CoC plus PhD/MSc. This indicates that the Norwegian combined robustness is considerably weaker compared with the largest international ones.

<sup>25</sup> Cfr. Watson Glaser Critical Thinking Appraisal (Harcourt Assessment Inc. 2007). This seems to grasp the core concept of critical thinking, cfr. Facione, Facione and Giancarlo (2000), Mason (2008) or the Quality Assurance Agency for British Higher Education (2010), who all include more or less the same elements.



#### 4.4.1. Valid CoC

Three out of eight foreign institutions demand a valid CoC and one recommends the same. This requirement demands that the personnel have to sail for a minimum of 12 months within a 5- year period or alternatively, take a course formally approved by the national maritime authorities for the renewal of CoC. The value of the latter is questionable, since it is the seagoing practice that gives value to teachers in the form of impulses from the industry influencing their teaching. An individual incentive for teachers to perform such seagoing practice might be the ability and flexibility it gives to revert to a position on board, for longer or shorter periods.

#### 4.4.2. Summary of relevant research activity

Institution A again, with a leading role producing 100 articles. Institution B and to a certain degree C also have a volume of relevant research articles. Our data excludes reporting the subject of research or its particular relevance for the BSc- program in nautical science. Thus, further analysis is needed in order to evaluate the direct / indirect relevance and weight attached to the nautical BSc-program. One reason for emphasising this is the fact that in Norway, institutions are given monetary incentives to produce research of quality, defined as peer reviewed in officially accepted journals, but no particular relevance to the BSc-program is required.

#### 4.5. Final projects or bachelor thesis

A final project or bachelor thesis is required by four of the eight foreign institutions and by all the Norwegian ones. The learning objectives may differ, but a focal point of universities is traditional academic skills. In addition, for professional studies in nautical science we find that some institutions have a concentration of subjects they encourage their students to explore. For instance institution A:

- Use of analytical, simulation and experimental methods to solve engineering tasks
- Make a critical analysis of the existing technical solutions and evaluate this solution
- Perform a typical device, object, system and process using the methods, techniques, tools or chosen materials

Supervision of students while working on their theses is another matter, and it might be a challenge for internal capacity and competency to supervise if students are allowed to choose their subjects at will.

## 5. Analysis

This section contains an analysis of the collected and received data. The quality indicators have been used for the analysis. The various national education system and their terminologies are not comparable worldwide and no uniform system exists. Where necessary, we have interpreted the given data, and such an interpretation could lead to misunderstandings and errors in analysis or conclusions.

### 5.1. Entry criteria and failure rate

It have been established that institutions A, C, D, F and Nor 1 have particular requirements in mathematics and typically emphasize logarithms, potencies, real exponents and polynomial factorization. In addition comes physics and the use of mathematical methods in order to explain the movement and force, energy and energy resources together with insight in climate conditions. This is similar to programs within technology and engineering.

The first argument in favour of these subjects as standard entry criteria is the fact that ship operations do require technical understanding, and the better this platform of understanding is when students start their nautical education the higher level and more in depth knowledge they can achieve.

Secondly, this will give nautical BSc. students a better, more advanced technical platform for further studies at MSc. level.

Thirdly, A, C, D and F all seem to score high in other quality indicators as well. Thus, in order to keep abreast with the level of competition that these institutions and their candidates give, the other institutions should consider implementing similar entry requirements.

There are, however, some contrary views regarding this rather traditional way of recruiting. Firstly, in particular in western countries, it is a challenge to recruit enough students to maintain the critical mass needed in order to defend the resources spent. Those candidates who satisfy particular requirements in mathematics, physics and chemistry will often have other options within engineering, science or medicine. This in turn has led to a wider recruitment policy and the question is whether this really reduces the candidates' competence as navigators.

Secondly, the demand for technical and mathematical knowledge may have changed – one may argue that navigators no longer need the same level of practical understanding due to the advanced technical tools available – with respect to navigation, loading and ballasting and monitoring the ship's operations. Further, if assistance is required in order to solve problems that can be solved while sailing, modern communication and on-shore advices are available.

Thirdly, future ship operations within 10-15 years will most likely be more if not completely autonomous. Thus, the demand for technical and mathematical knowledge on board will not increase, as ships are controlled from onshore.

However, despite the above pros and cons, they are to our understanding not necessarily of equal weight. Ships are technically more advanced, sophisticated, costly and carry more cargo than ever

before, thus, the risk of operating them at sea is not necessarily lower and still demands a high level of technical knowledge and skills whether they are operated from the bridge or onshore.

The next generation of navigators will still need traditional in- depth knowledge because the vast majority of ships built will be traditionally manned and operated. Thus the knowledge, understanding and skill to navigate and operate both these traditional and autonomous ships will require an ability to handle even more complex traffic situations and patterns, Such an ability entails further educational requirements, thus the better the technical and operational understanding navigators have when starting higher education, the more they can learn.

Regarding future competition we strongly advise that Norwegian recruitment be based on an intake level equal to or better than competing nations. We concluded in chapter 4.1 that in general today's recruitment seems adequate, but again emphasizing competition we advocate a discussion of whether such adequacy is sufficient to recruit applicants with not only the personal ability to develop navigational skills but also having a personality and the drive to become top officers in leading maritime nations.

Another aspect of matriculation was the level of English from secondary schools. The same argumentation as above is of relevance here; the higher level of understanding when starting, the more students will learn and the better skills they will have when starting their career on board.

Emphasizing Maritime Accident investigating reports,<sup>26</sup>we advise doing an evaluation of whether the Norwegian level of maritime English proficiency is sufficient, and how it could be continuously improved as a part of the nautical program development.

## 5.2. The structure and content of the nautical curriculum (ECTS equivalent)

### Model

Discussion of models and variations between the 12 institutions is of great interest because it is the very essence of how learning and training actually are done and there might be good reasons for keeping and developing a variation of practices. By mapping existing practices we hoped to get more insight, rather than finding "The benchmark-model", and we would like to stress that the non-Norwegian institutions chosen were not because of their particular model, but because they either serve the international shipping industry or represent important markets for this industry.

In general, the main purpose of a BSc. in Nautical Science is to fulfil the requirements of STCW Reg-II/1 and Reg-II/2, as well as the requirements of STCW Code A-II/1 and II/2. Furthermore, the study program could give relevant competencies beyond the requirements listed in STCW.

The competencies in the STCW Code could typically be structured in four ways:

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<sup>26</sup> Cfr. [www.gov.uk/maib-reports](http://www.gov.uk/maib-reports) and [www.martel.pro](http://www.martel.pro) indicate that as much as 50% of accidents caused by human error have their root causes in poor communication.

1. Cover the competencies at the operational level, A-II/1, subsequently the competencies at the management level, A-II/2. The so-called “sandwich model”.
2. Cover both the operational and management level within the same subjects e.g. Meteorology. The so-called “integrated model”.
3. A combination of items 1 and 2 above.
4. Approved seagoing service in addition to one of the above.

Only one of the institutions in the survey covers education limited to operational level.

Only two of the international institutions have a sandwich model, teaching competencies at the operational level (STCW A-II/1) separated from competencies at the management level (STCW A-II/2). The ten others adopt an integrated model teaching both operational and management competencies within the same subjects.

Five institutions have a 4-year BSc. program where cadet training at operational level up to Certificate of Competence (CoC) is included. Institution B has a particular variant in addition to the model with integrated training, where the sailing / cadet period is split between the first and second year of study and between the second and third year. The fourth year is purely theoretical with specialisation within seven different nautical / maritime subjects.

This education with integrated on-board training is clearly different from the Norwegian model with its 3-year BSc-program without any practical on-board training up to CoC. Norway has chosen to assign responsibility for cadet training to private shipping companies after completion of a BSc program, without any form of final examination after the cadet period. However, there is documentation of on-board training signed by an assessor with a particular training program as such and final approval from the Norwegian Maritime Authority.

The Norwegian Maritime Authority has per date (2017) no objections to the system. However, one may reflect upon the differences, and we find the following arguments in favour of the four-year BSc.-programs with integrated on-board training

- When students return to the university after their seagoing practice, this training allows them to reflect on their experience together with their tutors and staff thus, the students have a systematic follow-up of skills and knowledge that can show that the average candidate acquires a thorough level of understanding and knowledge. This seems to be verified by the interviews and when we asked about the effect of simulator training after a period on-board, the tutors emphasised that the students became more mature and their understanding of training increased.
- The students are enrolled on a study program that leads to an operational CoC.
- On the other hand, the BSc educational system with sea-going practice and cadet training leading to CoC demands either available training ships or a formalized and predictable cooperation with ship operators / managers: Professional education within nautical science requires huge investments and a long-term perspective. Thus, for Norwegian institutions to co-operate with the maritime industry and ship managers

requires both an intake level in line with offered ship capacities, and managers that commit to accepting a certain number of cadets on board.

This does not lead to a clear conclusion regarding the Norwegian cadet system, however there seems to be a disadvantage from not having any integration between theory and practice, both with regard to the practical skills learned and the achieved academic levels.

### Compulsory STCW subjects

Eight of the institutions have a concentration of ECTS points around 100 dedicated to compulsory STCW subjects. Four institutions differ, E with 81, F and NOR 4 with 127.5, while G seems special with 133 ECTS equivalents covering only operational level. In other words, the majority seem in line.

### Complementary subjects

These subjects typically cover mathematics, physics, language, history etc. There is a great variety between the institutions, also between the Norwegian programs, from Nor 4 with 15 ECTS to E with 95 ECTS equivalents. The consequence of loading up with complementary subjects is a reduced ability to apply time for in-depth specialisation within nautical / maritime subjects. Thus, profiling or branding a particular study program is more difficult to achieve.

### Nautical/maritime beyond STCW requirements

This category of subjects should be seen together with the final project or Bachelor Thesis, because both may contribute to the program profile or branding. The sum of ECTS gives a good overview of the students' possibilities of specialisation within the nautical / maritime field. Institution D, as an example, has marine transportation and marine operations giving in depth specialization within transport / logistics / commerce and technical operational subjects accordingly.

International trends of development are of importance for leading institutions; as leaders, they themselves set standards and interact with the maritime industry's global and national authorities' demands. The basis for nautical programs is given by STCW, however, even though this standard has been developed over the years, it is an IMO convention based system legally setting minimum requirements, while particular industrial segments and / or national maritime authorities may demand even higher standards.<sup>27</sup>. Within STCW a good example is Bridge Resource Management

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<sup>27</sup> This is seen in other areas as well, like the European Unions's "Erika Package I, II and III", cfr. EUR-Lex Erika Package covers almost every aspect of maritime safety and security – and a direct response to what was seen as the IMO's inappropriate ability or tardiness to deal efficiently with important safety issues.

(BRM) training, the maritime version of the aviation industry's Crew Resource Management (CRM). Leading maritime educational institutions developed BRM for maritime purposes over the last three to four decades<sup>28</sup>. Today it is part of STCW's requirements<sup>29</sup>. In other words, we advocate that in order to develop new concepts and innovative solutions efficiently one cannot await new formal and legally binding regulations, but must actively seek a dynamic collaboration between leading maritime research / educational institutions and the maritime industry. A particular challenge today is the development of autonomous ships, where technical- operational- and nautical management are core issues, together with legal and commercial challenges. How may leading institutions offer their BSc students both theoretical understanding of this development, and achieve practical skills needed in future autonomous ship operations? One practical challenge with including new learning into existing BSc-programs is that over the years the STCW minimum standard has increased – new concepts included, but old ones not necessarily deleted – thus leaving fewer and fewer hours available to new innovations and program profiling.

Nevertheless, we do find good examples of profiling or branding programs with in-depth specialisations; Institutions B, C and D all have clear profiling concepts. It is our understanding that Norwegian institutions indeed may improve their profiles so that their students to a greater degree do get in-depth knowledge of the latest trends of technical, commercial and legal demands for modern navigation and ship operation.

### 5.3. Simulators and laboratories

Up-to-date equipment seems to be the standard for all 12 institutions with some variations. This gives them a platform for offering and developing modern adequate education. In addition, most institutions have other simulators providing education and training within other areas than pure navigation and communications. The major difference is not in the different equipment, but how it is used. Some institutions introduce simulator training early in their programs, others later. Norwegian programs start early and the use of simulators seems to be well-integrated throughout the three- year study. This should be linked to the Norwegian role of developing the simulation of BRM, anchor handling and advanced offshore operations in close co-operation with the maritime industry. Here, problem- based learning (PBL) shows its importance of nautical professional education, cfr. comments above.

### 5.4. The academic/teaching staff

Practical and theoretical competencies possessed by the staff / tutors form the essence of any professional study program. To what extent is it of importance to combine the highest standard from

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<sup>28</sup> The background can be seen together with the development of the ISM Code, in the late 1980s new industrial standards needed in order to handle what was seen as too many casualties and occurrences at sea. A change in traditional recruitment policy and an intense focus on lowering operating costs also had an impact on the crews' ability to carry out their daily tasks properly, Cfr. Anderson (2005)

<sup>29</sup> STCW Code A-II/1, A-II/2, A-III/1, A-III/2, A-III/6, A-VIII/1, and A-VIII/2

practice, - i.e. master mariner for nautical programs - , with the highest standard with theory, i.e. PhD. and / or the years of research needed to achieve status as professor? Further, do the institutions need to combine these competences into one individual?

Firstly, if combined in one individual, that person will have the best possibilities of achieving insight within complex problems and the skills to obtain new theoretical insights and understand the need for changing study programs and teaching. In other words, the way from words to actions may be shortened, compared with study programs that are solely based upon practical understanding.

In reality, this is a difficult task to achieve for the institutions in our study. One remedy is to hire professionals with both CoC at management level and research competence at PhD level, if they are available at all, another way is to achieve the loop as described.

The lack of professionals with both competencies, make the above institutions hiring both former master mariners and researchers with PhD. degrees.

Secondly, the robustness of subjects taught and programs offered, as discussed above is also a factor to consider.

#### 5.5. Relevant research activities

A number of institutions do have robust staff with regard to both formal competencies as researchers and practical competencies with CoCs at management level. This generally may lead to a higher level of project development, research and innovation, as indicated by institutions with a high level of research articles. However, there is no per se causal connection between generally a high level of research activity and a high level of in- depth knowledge of the industry's most challenging technological-, environmental-, commercial-, and legal problems. Research may be carried out in a peripheral area to these challenges, of importance to the researcher and of clear interest, but maybe of less weight to the study program and industry? Clearly, we must also accept and encourage academic institutions to take care of and develop research in general. The challenge is the balance between a study program where applied sciences are core elements and other areas of research. All institutions shall not necessarily do everything, but may chose a profile of research, thus leaving other areas of research to others.

We advocate a strategy towards emphasising research of relevance and weight with regard to the core subjects or essence of nautical programs; navigation and operation / commercial and technical management of ships.

#### 5.6. Final projects or bachelor thesis

The final project or bachelor thesis must be seen together with research activities and the staff's capacity for tutoring. The question is, as for other programs, to which standards they are measured. The closer a thesis is to industrial demands and ongoing research activities the easier it is to evaluate whether it contributes to solving relevant industrial problems and verifies that the candidate has insight that are important for a position as officer and leader on board.

Professional BSc programs may be looked upon more as practical skills learned than in- depth theoretical knowledge – it is only possible to reach a certain level during three to four years when the students are required to spend a number of hours on training practical skills.

With reference to our comments above regarding ECTS beyond STCW requirements, one question is whether a thesis should be a specialization and in- depth study with the profession or a more general academic exercise. The study finding shows that it is quite possible to create a nautical program where project- related exercises gives students a theoretical knowledge, rather than a voluminous thesis that not necessarily verifies more in- depth knowledge or better understanding of complex problems.

Surely, there is no main discrepancy between writing a formal thesis and project reports if both are used to record group work on projects connected to industry and research and if both fulfil the standard needed in order to prepare students for further post- graduate studies. The bottleneck seems to be supervisory capacity; how do the program managers deal with the students and their chosen topics of analysis?

## 6. Conclusions

Our aim was not to find “the benchmark” within the model chosen, one may indeed ask if such a standard exists, but after examining the variety of models and practices the main findings are:

First and foremost, the finding regarding integrated on board training / cadet period through 4 year BSc.- programs leading to Certificate of Competence (CoC). This is in contrast to the Norwegian model of 3 years without CoC.

- We recommend that Norwegian institutions together with the relevant authorities and the industry start a process of evaluating the implementation of a 4 year BSc.-model with integrated practice.

Secondly, robustness is not evenly shared among the institutions. Some are clearly more robust with regard to both formal competencies as researchers and practical competencies with CoCs at management level. Norwegian institutions, both individually and as a whole, have fewer staff members with PhD’s and master degrees in combination with CoC at management level compared with the leading international institutions.

- We recommend that MSc. and PhD. programs are given increased focus. These programs should be seen in connection with the nautical BSc.-programs in order to further enhance their nautical relevance.

Thirdly, Norwegian institutions do have a volume of high standard simulator training. This gives a solid platform for further development.



- We recommend that the three observations above are seen together, as a modern nautical education is costly, and in order to further develop its quality. The model of financing this education should be evaluated and improved.

Fourthly, in our material there is no clear causal connection between the nautical students' level of proficiency and a demand for particular subjects beyond general high school fulfilment as an entry requirement. However, other studies<sup>30</sup> clearly indicate that a higher intake level gives better performance through the program, thus a higher intake level give a potential for improved learning goals.

- We recommend that the consequences of amending the entrance requirements for three of the Norwegian Nautical higher education programs are analysed further.

### **The working group**

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<sup>30</sup> Norwegian research with further references; Centre for Economic Research at NTNU; SØF-rapport 05/16: Kvalitetsindikatorer i universitets- og høyskolesektoren.

## Appendix 1.

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## Appendix 2

### Interview Guide

#### Introduction and background for the study

Based on the fact that your institution is from a highly industrialized and competitive nation, we assume that there exists a learning potential in our effort to develop our Norwegian nautical programs further. In other words, we regard all programs to be in accordance with STCW-78 as amended and our task is to obtain a relevant and thorough platform for further improvements.

Firstly, we would like to gather information about the data of your institution, staff and students. Secondly, we manage the interview and thirdly we do the evaluation of our Norwegian nautical study programs and compare with our findings.

In this interview guide we would look at five dimensions of program quality, and concentrate on elaborating these particular quality indicators.

We are most grateful that you have accepted to participate and we will make the final report available to you as soon as it is ready and accepted by our council. Please note that all institutions will be anonymized in the report.

#### Quality Indicators

- **Entry criteria's and final results.** Research indicate that the academic level of the entrants for the nautical study program will have an impact on the quality of the overall study. Research also indicate that a very low failure rate (below 5%) over time may lead to reduced quality of the overall study. Thus we find it vital to map the following:

**1a: ?**

**1b: Number of qualified applicants in relation to number of students enrolled in the program, (i.e. Admission rate) average over the five last years?**

**1c: (separated by 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> year)**

**1d: .**

- **Structure and content of the nautical curriculum introduction.**

In general, the main purpose of a Bachelor Nautical study program is to cover the requirements in STCW Reg-II/1 and Reg-II/2, as well as the requirements in STCW Code A-II/1 and II/2. Furthermore, the study program could give relevant competencies beyond the requirements listed in STCW.

The competencies in the STCW Code could typically be structured in four ways:

- 1) Cover the competencies at the operational level, A-II/1, subsequently the competencies at the management level, A-II/2. The so-called “sandwich model”.
- 2) Cover both the operational and management level within the same subjects e.g. Meteorology. The so-called “integrated model”.
- 3) A combination of items 2.1 and 2.2 above.
- 4) Approved seagoing service in addition to one of the above.

**2a: Please give a short description of your nautical study program based on the items described above.**

**2b: Please provide a study plan matrix showing subjects for each semester and the number of credits (not necessarily ECTS) allocated for each subjects and for the total study-program.**

- **Identify STCW related subjects**
- **Identify nautical/maritime subjects beyond the STCW requirements**
- **Identify complementary subjects e.g. science subjects**  
(See attached example on last page)

**2c: Please provide for each subject a short description, one page, including main objectives and content with reference to STCW Code and simulator training where relevant.**

**2d: Please describe the nautical students possibilities to have access to updated nautical publications, conventions and codes.**

- .
  - **3a Please provide a description of the navigational simulators and manufacturer of simulator bridges (full mission) and manufacturer of part task simulators (e.g. ECDIS, ARPA)**

**3b Please provide a description of other types of simulators and laboratories used by nautical students.**

**3c Please specify number of students on each bridge during exercises in the full mission navigational simulator.**

**3d Please stipulate the number of hours on navigational simulators for each semester per student.**

**3e Please stipulate the number of hours on other types of simulators and laboratories for each semester per student.**

- **Academic/teaching staff.**

**4a: Please provide a short description for each of your staff (anonymous) involved in nautical subjects and/or research. The description should include nautical competencies and academic grade.**

**4b: Do your institution require where applicable, valid CoC?**

**4c: Please give a summary of relevant research activities and published articles during the last five years.**

**4d: With relation to the summary in 4c: Please indicate how this research is incorporated in the relevant nautical subjects.**

- Industrialized countries typically include academic learning goals for their BSc. nautical study programs. I.e. the curriculum not only contains subjects as identified under 2b, but also a final project or thesis.
  - 5. a) Does the program contain a final project or bachelor thesis?**
  - 5. b) If yes, what is / are the learning goal(s)?**
  - 5. c) Are there any minimum requirements with regard to length / words or content?**
  - 5. d) Please describe how the students are supervised while working with this?**

**Example of study plan matrix. Note: The colours indicate if the subjects is ..**

.. related to STCW related subjects (blue)

.. nautical/maritime subjects beyond the STCW requirements (green)

.. complementary subjects e.g. science subjects (orange)

1 <sup>st</sup> Year		2 <sup>nd</sup> Year		3 <sup>rd</sup> year	
1 <sup>st</sup> sem	2 <sup>nd</sup> sem	3 <sup>rd</sup> sem	4 <sup>th</sup> sem	5 <sup>th</sup> sem	6 <sup>th</sup> sem
Electronics 5 ECTS	Applied mech 10 ECTS	Thermodyn 5 ECTS	Operation And Maint. 10 ECTS	Mar. Comm 5 ECTS	Data syst. 5 ECTS
Basic Navigation 15 ECTS		Meteorolgy 5 ECTS		Nav. 4 7.5 ECTS	Main Thesis 15 ECTS
Mathematics 5 ECTS	Navig Systems 15 ECTS	Ship Technology 10 ECTS	Cargo Handl. and Stow 10 ECTS	Adm. and Leadership 10 ECTS	
		Mar. Eng. 5 ECTS	Navigation Control and Ship handl 10 ECTS	Chartering 7.5 ECTS	
Mat. and Stat 10 ECTS		Mar Law 5 ECTS		Pos ref Elective 3 ECTS	Coastal Nav Elective 3 ECTS
Basic Safety 0 ECTS				Med. Care 5 ECTS	Adv. Safety 0 ECTS

**European Credit Transfer and Accumulation System (ECTS)** is a standard for comparing the study attainment and performance of students of higher education across the European Union and other collaborating European countries. **You should use the standards approved by the local administration.**