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BSc Maritime Technology Curriculum Revision: What Will the Future Naval Architect Look Like?

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BSc Maritime Technology Curriculum revision: What will the future Naval Architect look like?

Abstract

With the current curriculum developed and implemented in phases since 2013, it is time to evaluate and review the BSc curriculum. For this revision, the success and issues of the previous revision, the changes in our field and society, and the recent insights from educational studies are all reviewed to form the basis of this update. Current developments, like energy and autonomy transitions in the sector, as well as extra attention to learning processes and socialization, as a result of COVID-19, are all reviewed. The goals and vision will be discussed as well as current trends in the industry, science and education sciences. This will form the basis for a curriculum revision, followed by a comparison with related education to verify that a sound basis continues to exist. In the discussion, relevant considerations for Maritime Education, in general, will be drawn from this experience to support others in their updates.

Introduction

There is an old Dutch proverb that roughly translates as "Stagnation is deterioration". It indicates that anything that does not change over time will sooner or later be left behind or become obsolete. This is also true for education, as we are preparing our students for a future working life in an environment that is changing continuously. To stay relevant our education needs to be revised regularly at the course level, but also the curriculum level. This paper describes such an update, ensuring alignment with current issues and educational principles. The maritime technology bachelor degree of the TU Delft had its last major revision and update in 2013. Earlier revisions took place in 2000 and 2006, showing that updates usually occurred every 6-8 years. Considering papers published on curriculum revisions in general this period is found more often e.g. Kravtsov and Kobets (2018) argue for regular checks after 3-4 years and updates thereafter, but longer also happens Dopson and Tas (2004). In line with these observations, it is the view of the author that, curricula should follow changes in the industry. Actually, Forrester (1981) and later also Malecki (1981) are examples of studies that showed how innovation follows a similar cycle as the economy. Although it may still be a coincidence, already since the early 20th century, the economic cycle was also estimated to have a similar period (Clark 1917) of 7-8 years. In this case, the perceived changes in the industry as well as some issues in the curriculum led to the start of the revision which was made in late 2019.

However, in February 2020 COVID-19 reached the Netherlands and switching to a remote and online situation took precedence. With most of the restrictions behind us, the faculty used the moment to restart the revision of the maritime technology bachelor curriculum. Although the delivery of courses was more diversified than before, the content had not received the proper attention and should be reconsidered in light of the current developments.

It should be noted that, unlike many American and British programmes, in the Netherlands, the content is not directed through e.g. a professional society like SNAME or IMAREST as requested by ABET accreditation (ABET 2021). In the Netherlands, this is much more up to the faculty to ensure relevant education is provided. The government requires independent assessment every 5 years, with internal interim assessments halfway between two official assessments. Furthermore, an advisory board of professionals meets with the education staff twice a year to discuss concerns, content, potential updates and support. As a result, more freedom and responsibility lie with the programme organization itself. Still, we are used to looking abroad for insights as Maritime Engineering is the only one of its kind in the Netherlands. As a result, many ABET criteria for the content can be recognized, although we are not accredited by ABET.

This paper will discuss the update of the curriculum by first reviewing the previous revision of 2013. This is followed by a discussion of the societal changes affecting the study programme, including advances in education research. Next, the changes seen in industry and research are addressed. The result of these three analyses is a set of requirements for the revision to consider and the resulting curriculum is discussed. The result is benchmarked against 3 other bachelor curricula, chosen for their similarity in the study. Finally, a short reflection on the results and plans for implementation will be discussed.

Vision for the 2013 curriculum

The previous revision was primarily started to achieve two improvements. The first one was a decrease in the average study duration (at that time almost five years for the three-year bachelor programme). The second one was to deal with a new requirement for first-year students that banned them from access to further education if they did not at least achieve 75% of the credits for that year. This is called “bindend studie advies” (BSA) in Dutch. The 2013 curriculum took inspiration from the design spiral to show students and lecturers how each element is connected and knowledge deepens with each passing year. Also, each year would have an integration project at the end of the year to further strengthen the integration of knowledge learned in that year. Furthermore, course size was increased from 2-3 ECTS (European Credit Transfer and Accumulation System) to 6 ECTS for all courses or in other words each course would be 10% of the yearly provided credits. Finally, many projects were created to allow the mathematics and physics subjects of that quarter to be applied in the same quarter. The result is presented in Figure 1.

When considering the current study duration, this has improved with about 65% completing their studies within four years, this includes the 35% of the total students that finish in three years (based on the TU Delft Student statistics available to programme directors). Another 30% finishes in at most 6 years and the remaining 5% either does not finish or takes much longer. Unfortunately, this data is not available in this detail for the period before, but the median has gone down from 52-54 months to 46-48 months. Which is a significant improvement, but also still too long. The BSA itself was relatively successful, but as a study, we lose around 50% of our students in the first year and even without any ways to control the inflow, this is quite high and should be addressed further as well.

For completeness, there are around 100 students registered, but this could be for more than one study. In the first week, we see around 80 students that start the study. Of these students around 60 are active throughout the first year. Due to the BSA around 45-50 make it to the second year. These students that do make it almost all continue and complete their bachelor’s degree (98% on average).

Figure 1: Current Curriculum

The longer study duration is an issue as any curriculum redesign is forced to choose between designing for a nominal student or taking into account the variations of students taking longer. In part, this is a cultural difference, both the Dutch and German cultures are more likely to accept a longer duration as they do not accept giving a passing grade for an insufficient result. Other aspects, like fees, enrollment procedures, etc. all play a role as well. This differs per country, yet a full study on this is a paper on its own and has been left out of this investigation. Looking at Figure 2, it can be noted that three to four courses exceed the regular two exams per year offered. In general, these courses strongly build on previous knowledge in both mathematics and physics and demonstrate relatively poor knowledge retention. Such courses are accepted as they function as a kind of stage-gate, a quality check of our students, to verify if they can work with the acquired knowledge. Especially for "scheepsbewegingen" (ship motions), it can be argued that at the moment the course is provided students are not sufficiently ready yet and may have skipped valuable mathematic courses, or at least not fully understood them. The timing could be an issue here. For other courses, it is known that students often take them at a later time in the curriculum, when they are better able to deal with their often abstract concepts.

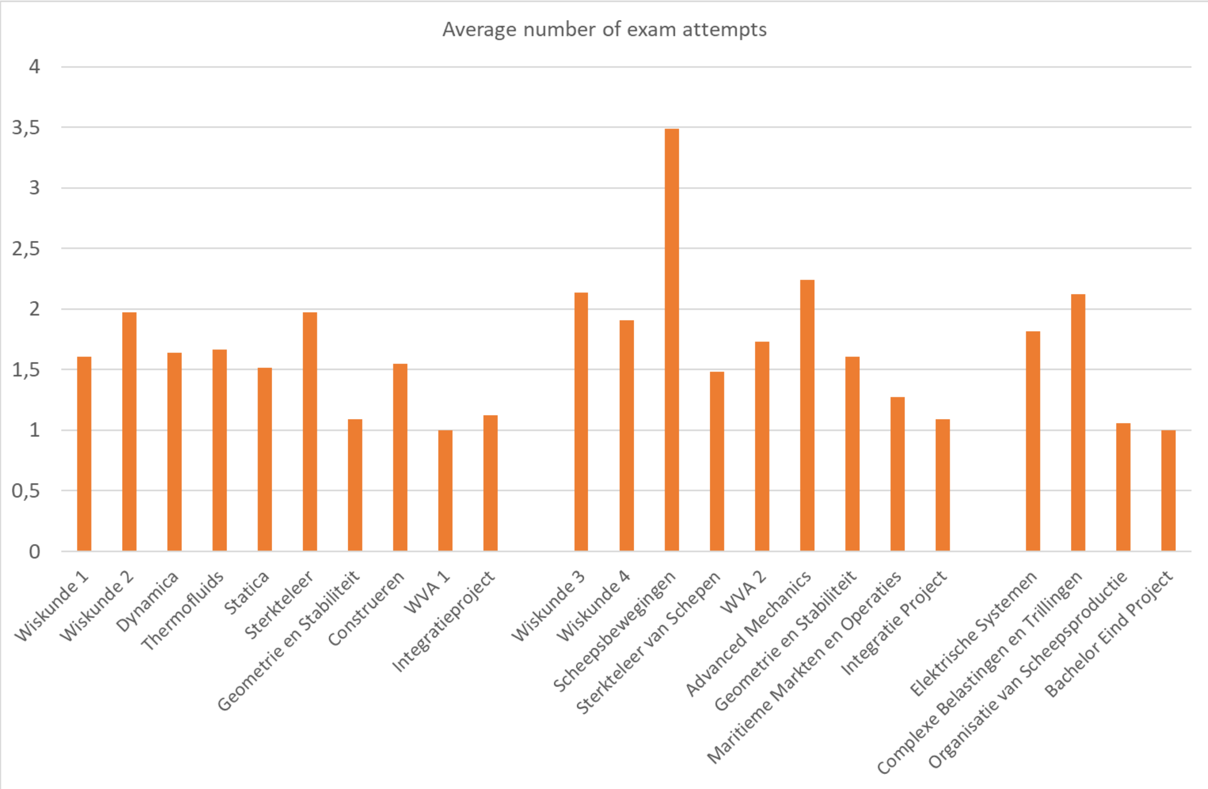

Figure 2: Average number of exam attempts per student

Finally, with the mathematics and physics courses provided by the faculty of mathematics and mechanical engineering respectively, it turned out to be very difficult to align the subject with the project flow, resulting in a doubling of work and a far from optimal learning experience. An example would be the hydrostatics course, which required elements of numerical calculations, regular calculus and statics. However, the timing of these concepts is ill-aligned with the project flow and as a result, also provided by the project lecturer in advance of the physics and math courses. Furthermore, many key maritime subjects were now given within these projects, which meant testing was difficult (projects do not contain exams in our curriculum).

Relevant societal changes

As indicated in the previous section, the percentage achieving our BSA and the average duration for our bachelor study has improved, but are not yet at the desired level. In the past 10 years, several variations in the form of government support have been seen. All had in common that improvements in education were expected to lead to reductions in study duration. This means our programme should continue to improve these values.

Controversially, an increase in the difficulty of the BSA could very well lead to a reduction in the total duration. To explain this, the assumption is that now only the better students make the cut and thus culture will change and study duration will drop. Also, it will be considered normal to pass an entire year, instead of only 75%. Such a result can be seen with another study that is allowed to select their students due to the very high popularity, Clinical Technology. Their median duration is 35-37 months and almost all students have completed their study by the end of the fourth year. Of course, other factors cannot be excluded, such as a different approach or level of education, but based on conversations with lecturers of Clinical Technology, student quality and culture are deemed to be the key factor. Hence, more focus on the culture and perhaps even on the way we attract students could be relevant in the same matter as changing our courses could be.

Besides pressure from the government, another relevant impact was the recent experiences with COVID-19. This pandemic was already mentioned in the introduction as a reason for the delay in the curriculum update. Besides this, COVID-19 was also a great disruption for our societies. From the perspective of education, it was on the one hand a pressure cooker for innovation (e.g. Adelowotan (2021), Adnan and Anwar (2020), Karma, Darma, and Santiana (2021), Van Wyk et al. (2020)). On the other hand, it also showed the fragility of our education system. Despite our best efforts, there are caveats in the development of the learners attributable to the situation during COVID-19. Maybe not in knowledge, but especially in skills. Most clearly, we notice this at the moment in their Master Thesis projects, where many students struggle with asking for input and support both from fellow students and supervisors. Instead, they isolate themselves further, trying to solve the issue on their own. As a result, we are currently more aware of the socialization role education provides besides knowledge (Adelowotan 2021; Gromova 2020; Lepp et al. 2021). Socialization is a complex concept, but in our view, it contains not only the interaction with others, but also the identification with a group, a sense of belonging and the acceptance and transfer of their culture, not only between students, but also between students and lecturers.

Finally, although the Bachelor-Master structure was implemented in Europe in the year 2002-2003, in the last 10-15 years this structure started to have more impact on our education. Before this structure, most engineering studies were a single-degree study of 5 years with no means to switch at an intermediate point. So, in essence, your Bachelor's and Master's degrees were always on the same topic. This remained the common way of studying for a long time. Now, more and more students, around 35% in our case, switch studies after achieving their Bachelor’s degree. In our master programme, we see that 35-45% of our inflow has not followed our bachelor programme. In the beginning, this was at most 10-15%. Although this impact is larger for the master programme, it does mean that we need to be aware of the paths our students may (want to) take. At least we should maintain a solid engineering foundation, to allow our students to join other master programmes. At the same time, there is not much benefit in advancing far beyond the common practice of other bachelor studies abroad. This could even lead to difficulties in the master’s programme.

Relevant changes in the maritime sector

On December 15 2012 at COP 21 in Paris, France, the Paris Agreement was signed between 196 parties to start the effort of limiting the global temperature increase to 1.5 degrees Celsius (UNFCCC s.d.). On April 13 2018, the International Maritime Organization (IMO) adopted resolution MEPC.304(72) on Initial IMO Strategy on the reduction of GHG emissions from ships (IMO 2019). This made the goal of reducing the impact of climate change from ships clear for the first time. On July 14 2021, the EU announced the latest step in the effort to address climate change. Under the name of Fit for 55, all industries including shipping will have to deal with stricter reductions than announced till then. Figure 2 below gives a brief overview of the targets set by both the EU and IMO in their pursuit of an energy transition for the next 80 years. Although it is expected more legislation will follow on top of this.

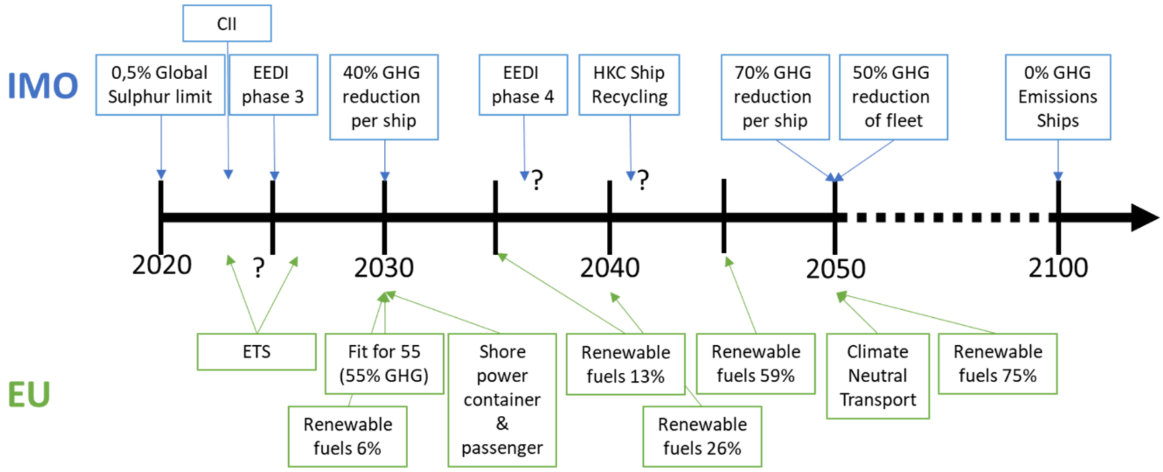

Figure 3: Increasing pressure from legislation for ships to become green

The impact of shipping was established in the IMO 4th GHG study (IMO 2021). It also contains an extensive literature study on emission reduction techniques for ships and the reported potential of each technique. It clearly shows the need for alternative fuels for shipping to achieve the goals set. However, although research into the energy transition has dominated the output since then, it is still very uncertain, which fuel or fuels will replace the dominance of fossil fuels in shipping. Already for 2022 alone 136 papers appear in a Scopus search on “fuel AND alternative AND maritime" and this only covers one aspect of the energy transition. As a result, the landscape of the ship designer has and continues to change. Something that should be reflected in its education as well.

Similar to the energy transition, the term fourth industrial revolution was first used in a publication of the world economic forum in 2015 (Schwab 2015). It encompasses increased connectivity to the internet of systems. As a result, more data has become available and also autonomous equipment is often seen as a part of this revolution. As a result data collection systems for ships are now sold with vessels, to allow yards, engine manufacturers and owners to collect large amounts of data on their vessels and equipment. Clear benefits and improvements are not yet achieved, but with research in this direction, our knowledge is growing rapidly. Furthermore, with the Yara Birkeland, the first fully autonomous vessel is sailing a fixed route in a fjord in Norway (YARA s.d.) and more projects will soon operate (e.g. (Promare 2022) and (Cables 2022)). Although individual courses address such events, a clear approach to the skills future engineers may require to handle this revolution has so far not been established.

Relevant advances in education research

Traditionally the focus of education at (Dutch) technical universities is on Math and Physics courses (Mudde et al. 2017). Yet as already indicated in the introduction of this paper, COVID-19 has shown that education is much more than transferring the technical content alone. Especially the importance of transferable skills, such as teamwork, programming, presenting, etc. has increased in the last decade (Byrne et al. 2021; Crawley, Lucas, and Brodeur 2011; Saunders-Smits et al. 2022). This is often not recognized by students and many of these skills are practised in a group setting. As a result, students tend to focus on their strong skills, optimizing the time required for the assignment, but not developing any new skills. This is primarily motivated by maximal impact with minimal effort (Ambrose et al. 2010; De Bruyckere, Kirschner, and Hulshof 2015).

The absence of certain skills is often only noticeable by the end of the master's when students perform a large (9-month) individual research assignment. At that time, it is too late to correct these issues extensively, although one-on-one tutoring does make up for some part of the deficiency. In our current curriculum (see also Figure 1), students receive extensive skills training in the first year, are expected to apply and develop this further in the second and third years and are tested on parts of this (teamwork, writing and presentation) individually in their Bachelor End Project (BEP). Due to this, many become the victim of the impact maximisation described above as a result. Even though our approaches make sense at the course level, at a curriculum level there is too little variation to challenge them in their choices.

Another recent development found within the Netherlands is the introduction of the Reflective Engineer. The idea behind this is twofold, due to the increasing speed of change in our society, we are all forced to become lifelong learners, so we need the skills to reflect on our abilities for this. Furthermore, the (self) reflection will help students make more deliberate choices concerning their study behaviour and goals, resulting in higher intrinsic motivation and results (Leary 2012; Reinholz 2015; Saunders-Smits et al. 2022; Trede, Macklin, and Bridges 2012). Developments are not yet standardised but differ per master programme. Although all follow a focus on self-assessment, reflection and peer group support.

Adaptation of the concept towards the bachelor has not yet been found, although it inspired us to implement a more extensive mentoring programme, with a focus on learning to learn and reflecting on your learning already in 2020. As a result, our BSA success rate seems to have increased from 45% to 55%. Although this claim is difficult to make, due to many irregularities since 2020, such as COVID-19. Still, based on feedback from students, this support does seem to benefit their awareness and also the group forming. Elements that do lead to a higher intrinsic motivation for the study. Further exploration of this subject would be therefore advised.

Update development for the MT curriculum

All of the developments above were identified at the start of the redevelopment and led to a clear assignment for updating the curriculum. The content of the curriculum should find a way to deal with the current scientific and sectoral developments of the energy transition and increased digitization. Also, the development of skills should be given more attention, ensuring individual learning goals and verification, as well as a more diversified application during the courses, especially in the second year.

Considering the format for courses, large courses have proven to be effective and should be maintained as much as possible, however, learning new materials in a project setting does not work and should be avoided. Project courses were designed as larger assignments for a group of students to integrate various skills. Materials for the project are provided in lectures alongside the project, but application and learning of the content are limited, due to the division of work in the team. Project work should focus on developing (interpersonal) skills and applying existing knowledge. As a result, it should only offer a very limited amount of new knowledge. The application of (abstract) knowledge from classical lectures improves knowledge retention. The integration of content offers the students a broader connected view at the start and the end of the year. This will also help increase retention by supporting a frame of reference (Kirschner and Hendrick 2020; Van Merriënboer and Kirschner 2017). Furthermore, especially for the first year, it should be accepted that the ability to influence math and physics courses is limited. We should preferably move the maritime application to the quarter after the basic knowledge, to ensure all knowledge is present and allow for more depth of the subject in the practical application.

A curriculum committee was installed with members from each of the learning lines (design, hydrodynamics, structures and marine engineering) as well as two student members to discuss and identify suitable solutions to the issues and directions presented above. These members would discuss ideas and changes within their teams, to create awareness and support early on. At regular intervals, broader discussions with all staff were held. The first one was used to verify the goals for the revision and the second one was used to discuss the course set to be implemented. In these sessions, elements were discussed until a consensus was reached. Given the limited amount of staff involved in the bachelor (around 20 persons in total), this was achievable. With respect to the learning goals, these were determined in separate sections aligned with the learning lines and crosschecked by both the curriculum committee and student bodies.

Figure 4: New Curriculum

The result is presented in Figure 4. When comparing this figure to Figure 1, it should be clear that the majority of the changes took place in year one of the study programme. The amount of project work has been reduced from 24 ECTS to 8 ECTS in an effort to increase individual knowledge gain and retention. As a result, courses were able to move to a later quarter to ensure all information is available for the previous math and physics course. In the first quarter, an introduction course was introduced to show the bigger integrated picture of the study and how all subjects are interlinked in the design of a ship. This is further strengthened by the two integration projects, that demonstrate the same principle. This project is cut in two for organizational purposes, but in fact, is one continuous project. Within this project, the focus is on skills development, alongside the integration of knowledge.

As part of the course "Maritime Markets and Operations" was moved to the first year, it was possible to create a course more focused on the fundamentals of ship design and production in the second year. Ensuring that the project in the second year would also be more focused on gaining and practising skills as well as all knowledge provided in the first semester. Furthermore, several courses were relocated to align better with the required knowledge, such as advanced Mechanics and Ship Motions. Finally, space was created to introduce systems and control, a course already part of the Mechanical Engineering bachelor programme but until now part of the Electrical Drives course for Maritime. The drives course was refocused more on energy and conversion, as this subject becomes more relevant with the energy transition and the limits of alternative fuels. With the energy transition in shipping taking shape right now, a key subject to understand better for our students. Finally, some courses were renamed to better reflect their content, such as "Strength of Ships" into "maritime structure mechanics".

The course plan is only able to show part of the changes that took place within the curriculum, many changes took place out of sight, but reconsidering our learning goals and realigning them with our views on the future. To discuss these on a course-by-course basis would be too extensive for this paper, but Table 1 shows an overview of the key content elements we have added or removed from our programme, as far as possible grouped by learning line.

Although at first glance it seems a lot was added, in reality, many subjects can be treated with little effort. Starting from the top, Manoeuvring is added to ship motions at the cost of some more theoretical approaches and by focusing more on understanding the principles than replicating the theory. Launching and groundings were already part of the curriculum, but not under the subjects of Hydromechanics, so these are reallocated only. The impact of sustainability is now mentioned explicitly but was already part of the courses.

Systems engineering and design for production are changes to existing approaches to a subject. These are taught by changing the application and instructions but do not require increased lectures at this level. We just feel these newer approaches are more relevant given the ongoing energy transition. Similar to sustainability, alternative fuels are a small addition. The combustion process is the difficult-to-understand part, discussing the changes a choice in fuel makes, is just a limited extension.

On the other hand, the extension of system and control and energy systems has led to splitting up this course into two separate courses as can be seen when comparing Figure 1 and Figure 4. Finally, as discussed above, the increase in skills education and application was much desired. This is never provided as a stand-alone subject but is always integrated into a course.

Table 1: Overview of content added, removed and remaining

	Added	Removed	Remaining
Hydromechanics			Resistance
			Propellor functioning
			Cavitation
	Manoeuvring		Ship motions (in waves)

		Lines plan hand drawing	Hull shape
	Launching, grounding	Sailing with sails has been reduced	Stability
Structures			Stiffened plate field design
			Material qualities/impacts
			Failure modes
			Dynamic behaviour (1 and 2 DOF)
Design, Production and Operations	Impact of sustainability		Economics (trade, logistics and business)
			Ship, parts and equipment typology
	System Engineering concepts	Design spiral	System Integration
	Design for Production	Production optimization	Production Process
Marine Engineering			Powering
	Alternative fuels		Combustion Engines
	Battery part extended		Electrical systems
	System and Control extended		System control
Skills	Skill extended, including data handling skills		Programming
			3D drawing skills
			Metalworking
			Presenting
	Review and Argumentation		Literature searching
	Extended with extra support		Reporting
			Study Skills

In this way, we believe to have addressed in a balanced way the concerns raised in the discussion to a large extent. However, several extra measures, not visible in the data presented until now have also been taken to further address these concerns. As can be seen, we have increased the courses and number of exams in the first year, this could negatively affect the BSA, but could positively affect the overall study duration. In an effort to counter this, a trial study day is introduced for all prospective students (see e.g. (Leenheer 2022) on the importance of checking for matching early on). This day is mandatory and consists of a self-test on motivation and alignment with the study, lectures in math, physics and naval architecture concluded by a small exam, lunch with current students, discussions with study counsellors and a tour of the faculty.

The goal of this day is to allow students to meet with their future peers and start connecting earlier, but also to give them enough input to reflect on their choice before committing a full year to it. This was implemented ahead of the curriculum and the results indicate a higher intrinsic motivation of the current group and also a larger part of the prospective students joining the programme. It is at the moment too early to see if also the BSA passing rate has improved, as this will only be known by September 2023. Of course, conclusions are not very strong as this is only the first year.

Benchmarking of the new curriculum

Before committing to the programme as developed so far, an important step is to see how this aligns with other similar programmes. Especially as our master's students will come from diverse backgrounds, it would be best to be able to build on a similar knowledge level. In the 2013 review, a benchmark was done on all universities that are a member of WEGEMT (European Association of Universities in Marine Technology). It was found that the TU Delft offered a much broader focused bachelor and master programme than the other member institutes. Therefore, the decision was taken to focus on a small number of programmes that offer more similar content to enhance the relevance of the benchmark. The following four programmes were selected based on the fact that these studies are the most closely related ones to our own programme. Each teaches a mix of marine engineering and naval architecture in a programme of a similar duration:

1. Ship Design at the Norwegian University of Science and Technology (NTNU)
2. Naval Architecture and Marine Engineering at the National Technical University of Athens (NTUA)
3. Naval Architecture and Marine Engineering at the Webb Institute (Webb)
4. University of Southampton, UK (UoS)

It should be noted that both Webb and NTUA offer 4 years of courses, while TU Delft, NTNU and UoS only offer 3 years. This is in turn offset by the duration of the master leading to 5-year programmes in all cases to achieve a master's. The first comparison made is based on the fraction of credits spend on the various subjects as identified at TU Delft. These learning lines may differ between institutions and an effort was made to best align each course with the content as present at TU Delft. The overview in Figure 5 clearly shows the more general basis provided at the NTNU compared to others, scoring significantly higher in Mathematics and Physics. NTUA gives more attention to Strength in its curriculum, with advanced 4th-year topics. While UoS offers a significant amount of extra managerial courses compared to other engineering studies. Finally, TU Delft is focused less on specific skills courses than the other universities. Something addressed to some extent in the new curriculum, but still to be considered. It could be that many skills are intertwined with regular courses.

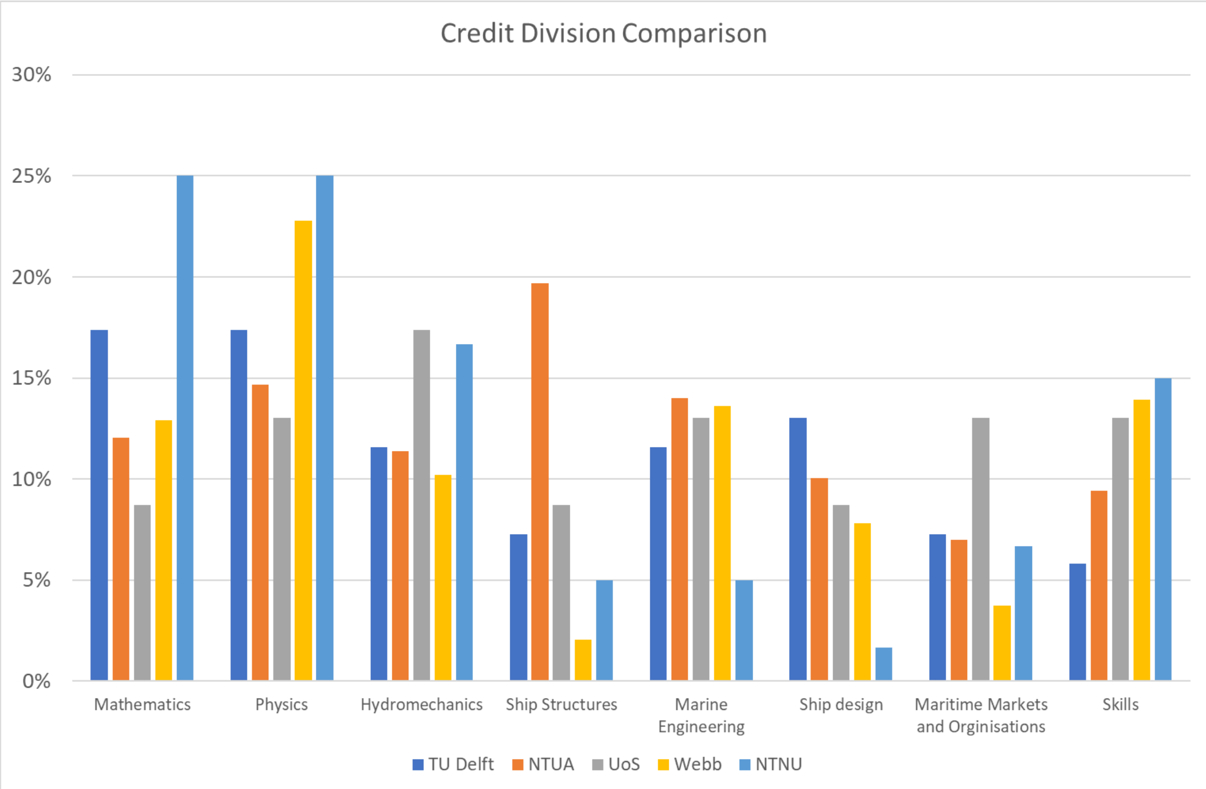

Figure 5: Comparison of credit divisions in the benchmark

After further exploring the learning goals of each individual course, several key differences can be highlighted further. In Table 2 the results are summarized. Although differences are clearly present, some can be contributed to the longer duration, like with the advanced strength subjects at NTUA. Others are not consistent over all curricula, meaning there is not a single subject in which TU Delft is exceeding all other universities and neither is there a subject which TU Delft is lacking according to the benchmark universities. Overall the new curriculum is in line with the other universities at least concerning learning goals.

Table 2: Results of learning goal comparison in the benchmark

Compared to TU Delft	NTUA	UoS	Webb	NTNU
Extra	NTUA has more focus on how to act as a manager. Also, there is more focus on fatigue and strength of engines besides the vessel's structure.	UoS offers more management courses and also more in-depth knowledge about CFD	Webb mentions nuclear prime movers and shows more auxiliary systems. If it comes to fluid dynamics, there is a mention of the material derivative	NTNU mentions the material derivative and makes flow calculations using basic CFD. They also address reliability in their marine engineering courses. Furthermore, NTNU has a

				philosophy course and a course about object-oriented programming + GUI.
Missing	The NTUA has no focus on either pumps or propellers when it comes to their propulsion courses.	UoS seems to only cover the first year's structure and production courses of the TU Delft.	Webb starts their structure coursed in year 3 and these only cover the first year's structure and production courses of the TU Delft.	NTNU has less focus on ship propulsors and their characteristics, furthermore, there is very little focus on practical ship design courses in the BSc.

Discussion

Any curriculum is the result of a design process and in essence, a compromise between content, skills, time, teaching staff availability and qualities. On top of that educational philosophies can drive the delivery and approach more in one or another direction. Within this paper the result of a redesign of the curriculum was described, with two main purposes; to identify key changes in our surroundings which is the maritime sector, that require adaptations of learning content. This can be used by others as well to review their existing courses and learning goals. Yet it may also be to some extent locally inspired, driven by the industries present in the Netherlands. The second goal was a discussion of the success of skills and socialization in education and their role in study success. Even though the validation of the success of these approaches is limited, due to influences of the COVID-19 pandemic and/or limited results available at the moment. The ideas brought forward here could inspire other educators to investigate these elements also in their own education.

Currently the curriculum is monitored at different levels. The NVAO is concerned with the accreditation of university curricula in the Netherlands and assess a programme every 5 years on the basis of four standards; Vision and quality assurance, Vision implementation including tests, facilities and staff, Validation of final qualification and Pro-active improvement of the education [Ref beoordelingskader]. With the next accreditation in 2025, further input on the curriculum will be provided by a group of experts. As part of the pro-active improvement of the education, many instruments are provided to already monitor the impact of the curriculum and course updates. There are course evaluations by students, additional assessments of study success, a yearly student exit evaluation as well as quality year reports which contain student study durations, average credits obtained, BSA success and comparisons with other studies. Besides this we have introduced time registration (voluntarily), which gives further insights into the efforts of students for courses and quarters as additional input. All these measures will be used to monitor the success of the curriculum in combination with lecturer feedback and insights and may lead to smaller adjustments over time.

Finally, and perhaps most importantly, this paper is the basis for a discussion at the conference itself with peers. Their ideas and suggestions are very welcome to further improve this curriculum, as only the first year will be implemented in the coming educational year.

Conclusions

After ten years an update of the BSc curriculum of Maritime Technology at the TU Delft was required. This was started by a review of the current curriculum and our experiences with it and followed by a review of changes in the field and educational sciences. The result is a curriculum with more focus on individual knowledge gathering, but still with sufficient applications of this knowledge in projects and assignments to bring this knowledge together. Furthermore, each year not only ends but also starts with a course that integrates the various fields and shows how they are all related. These choices were made to improve knowledge retention and reduce the overall study duration. To deal with the first-year up-or-out system, the BSA, more effort was put into socialization, both before and during the year. Over the next years, results will be monitored and we hope to be able to present a positive impact of this redesign in the future.

Acknowledgements

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