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RESEARCH ARTICLE



# Disciplinary knowledge, pedagogy, and assessment in non-university marine engineering education – consequences for student academic success

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## ABSTRACT

This paper explicates the codes that prescribe and shape the marine engineer student in times of massification and high attrition rates in Danish non-university higher education. In a case study of a Danish school of marine engineering, the Bernsteinian concept of knowledge structures and Legitimation Code Theory support analysing the official curriculum along with teacher and student interviews to determine what is considered knowledge and whose knowledge is deemed important. We find that teachers' pedagogical decisions are embedded in the epistemological and social conventions of their individual educational backgrounds. Their struggles on content and pedagogic approach make it difficult for students to understand what is legitimate knowledge and who can claim to be a legitimate knower. To offer more students epistemic access to non-university academic study and increase student success, the epistemic and evaluative logics of the pedagogic discourses to which students are exposed must be clarified and made explicit.

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Legitimation Code Theory; disciplinary knowledge; academic success; widening participation; non-university higher education; academic drift

## Introduction

The global pressures currently being exerted on higher education (HE) are well-documented, with contestations about the purposes of HE, widening participation, and diversification in a context of shrinking financial resource bases (Shay 2014; Burke 2012). Following the Bologna Declaration in 1999, we have seen in Europe changing demands resulting in a more uniform system of qualifications in university and non-university HE: practice-oriented institutions have turned to more science-oriented curricula and universities increasingly develop profession-oriented curricula (Teichler 2008). In non-university entities (vocationally and professionally oriented post-secondary education institutions), a consequence is the so-called 'academic drift'. 'Academic drift' occurs when educational policies induce non-university institutions to 'strive to become like universities by incorporating university structures and emulating their values, norms, symbols and practices' (Christensen and Newburry 2015, 33). Although

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the existence of this drift has been widely documented, so far remarkably little attention has been given to explaining it.

Presently, in Denmark and the other Nordic countries less than half the teachers at non-universities have a higher education degree. Rather, teacher competence has been primarily based on their skills as capable craftspeople (Jørgensen 2017). Little is known about whether teacher diversity in these educational contexts leads to students struggling with understanding the epistemology of their discipline. However, how knowledge is relayed—i.e. the ways in which individual teachers assess, the sorts of tasks they set, and the kinds of learning they believe are taking place—is all bound up in their notions of epistemology (Knight, Shum, and Littleton 2014). This suggests that certain curricula are legitimated and others are not and that students need to understand the inherent, inexplicit methods to succeed (Hindhede 2020). Whereas those with vocational qualifications are now formally eligible to apply for academic studies, secondary education continues to prepare its students for certain kinds of post-secondary choices (Haltia, Isopahkala-Bouret, and Jauhiainen 2021), indicating that non-university teachers are confronted with ill-prepared students who are estranged in relation to HE (Nylund et al. 2018). We hypothesise that this may lead to higher rates of attrition. Certainly, we see an increasing political focus on student enrolment, efficiency, and completion as poor student success seems to be antithetical to the government's politics of an emancipatory educational agenda. Ascertaining which factors are related to academic achievement in students is therefore important both for academic institutions and for their students (Brunborg et al. 2010). Whether unfamiliar individual teaching practices constrain learning of non-university HE students and lead to high attrition rates remains under-explored.

## Context

The schools of marine engineering in Denmark were recently accredited under the Danish accreditation legislation for higher education. Therefore, state authorities have adjusted their expectations for these non-university institutions from being part of post-secondary educational system towards being part of the higher educational system (Kyvik 2004).

The school of focus in this study increased its number of students from 200 in 2010–800 in 2021. However, like other undergraduate engineering programmes (Winberg et al. 2016), this school is marred by high attrition rates and poor student success, with many failing their exams and approximately 30% dropping out in the first year. In order to better understand who this institution wants its students to become and what it wants its students to know, we ask:

*How is knowledge relayed within the school of marine engineering? And how do the forms of knowledge enacted in pedagogical practices affect the students in their struggles to achieve academic success?*

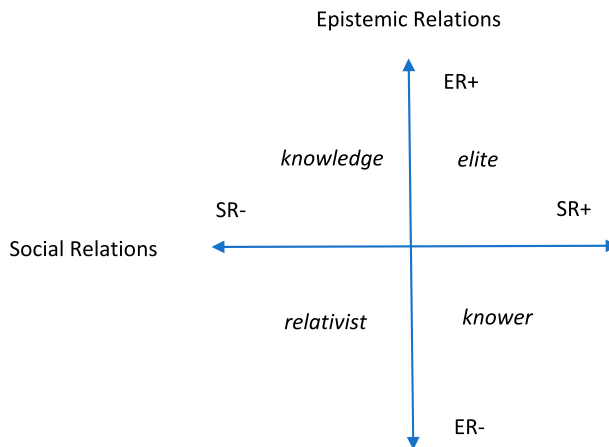
To attempt to answer these questions, we draw on a theoretical framework which enables the conceptualisation of curricular and knowledge contestations. Our analysis draws on the Bernsteinian (2000) concept of knowledge structures, and our analytical instrument is inspired by Legitimation Code Theory (LCT) and the concept of *specialisation* (Maton and Chen 2014).

## Conceptual framework

Bernstein (2003) conducts an empirical investigation and theoretical elaboration of how the distribution of knowledge relates to hierarchies in society. According to him, there are three interrelated message systems of schooling: curriculum, pedagogy, and assessment: ‘Curriculum defines what counts as valid knowledge, pedagogy defines what counts as valid transmission of knowledge, and evaluation defines what counts as valid realization of this knowledge on the part of the taught’ (Bernstein 2003, 85).

Whereas Bernstein focuses on structures of knowledge, Maton and Chen (2014) adds that every educational field also has a structure of knowers. In fact, ‘each discipline structures its knowledge and determines the kind of knowers who are deemed worthy of disciplinary membership’ (Winberg, McKenna, and Wilmot 2020, 2). The objective then becomes identifying what the specific and various legitimation codes are for marine engineering. An analysis of the school’s knowledge and knower principles can help to expose the potential challenges related to students’ decoding of what is required for success in the programme. What characterises the knowledge principles in relation to which the students are expected to orient themselves, and are there characteristic differences in the coded pedagogy among teachers? Are some groups of students more privileged than others? With what are they privileged? By analysing the (visible and invisible) codes and reporting them back to the school, it will be possible to improve the conditions for all students to learn (Maton 2020; Jackson 2016; Howard and Maton 2011).

Specialisation is about identifying the means by which a field is specialised and thereby highlighting what constitutes success in the field. It comprises codes of both epistemic relations (ER) and social relations (SR) (Maton and Chen 2014). Maton and Chen (2014, 30) represents the relationship between epistemic relations and social relations graphically on a ‘*Cartesian plane*’, as shown in Figure 1. ER is about the strength of relations to the object of knowledge and is enacted as the degree of emphasis (ER+/-) on specific and explicit knowledge, and on procedures or techniques as the basis for teachers’ curricular and classroom practices. In addition, SR is about the strength of relations to the subject of knowledge and is enacted as the degree of emphasis (SR+/-)



**Figure 1.** The specialization plane. See Maton

on students' personal opinions, beliefs, and/or positions as the basis for valorised pedagogic practices. Teachers as actors in a field of struggle may emphasise the particular knowledge (ER) to a greater or lesser degree and the disposition of the knower (SR) to a greater or lesser degree.

## Educational context

The Bachelor of Technology Management and Marine Engineering Programme qualifies graduates at a management level of ships- and shore-based companies to assume responsibility for the operation and maintenance of technical plants and installations, including ensuring that the plant and installations operate optimally in terms of safety, operating economies, and the environment. The education was recently classified as a bachelor's degree and thus regulated by the European Qualifications Framework level 6 (Council Resolution of 27 June 2002 on lifelong learning). Applicants must have either an upper secondary school leaving certificate (UPS) or a background in a skilled trade. Before starting the three-year theoretical part of the program, applicants without a skilled trade background must attend a nine-month workshop course followed by a nine-month internship.

The specific school of marine engineering has approximately 45 employees; 38 of these are teachers (13 engineers and 25 machinists) with an average age of 57 years. The student enrolment is gender-biased, with 95% of the students being male. Furthermore, half of the students come from skilled trades. Fifty percent of students fail in all exams, which has resulted in the school increasing the resources it expends on re-examination and repetitive teaching. As part of the accreditation, a mid-term evaluation is conducted each semester and is meant to provide the teachers with students' feedback on their teaching, affording teachers the opportunity to make changes accordingly.

In this context, education is free. State-financed student aid and subsidised loans enable students to pursue education, irrespective of their financial circumstances.

## Methods

This study is part of a larger study wherein we were invited by management to bring curriculum development expertise to the team developing the educational programme at the school. In this paper, we draw on text analysis of teaching materials, framework provisions, and management's annual reports for the past five years. In addition, interviews with teachers ( $n = 11$ ; 4 engineers and 7 machinists) and students ( $n = 9$ ; representing all semesters from M4 to M8) were conducted. The respondents were the ones who volunteered to participate in the interviews. We were interested in teachers' and students' judgments of the 'right' kind of knowledge and the 'right' kinds of students to investigate what can be described as legitimate knowledge (epistemic relations) and who can claim to be a legitimate knower (social relations). Regarding the empirical realisation, we focussed on how Bernstein's three message systems (curriculum, pedagogy, and assessment) are enacted in curriculum documents, in teachers' representations, and in learners' experiences. The interviews with teachers explored: (1) the basis on which they had selected target knowledge for their lessons and courses; (2) how they conceptualised knowledge-building over the duration of the programme; and (3) if and how they worked

with students' pre-existing knowledge about the topic being taught. The interviews with students explored: (1) what they considered to be valid knowledge in this educational context; (2) how this knowledge was taught; and (3) what they considered to be the learner's legitimate realisation of this knowledge.

The interviews were transcribed and coded in Nvivo to assist in organising and analysing the datasets. Excerpts or quotes that could be useful for further analysis were categorised according to Bernstein's three message systems and Maton's epistemic and social relations. When study regulations and all interviews had been coded, we went through the variants one by one and wrote down all the quotes from the different interviews on a separate document for the purpose of an easy overview of the different variants of knowledge, knower, relativist and elite code practices, and pertinent data. Due to limited space, in our analysis we focussed less on the content of the curriculum and more on the principles structuring the curricular and pedagogical enactment as it was represented in the interviews.

We sought and gained approval of the project from the Danish Data Protection Agency. We sought advice on obtaining ethical approval, but as this project did not involve clinical interventions, we were advised that no formal ethical clearance was required. The participants were informed about the aim of the project and were asked for their informed consent. They were promised anonymity and could withdraw from the study at any time for any reason. We have used fictional names and omitted information on respondents' age, etc.

## Findings

### *Bases of legitimation of the curriculum*

We found that the training at the school must meet certain requirements from, for example, the Danish Maritime Authority. The education is structured with a theoretical part of the programme during which the students are introduced to a variety of subjects that are supplemented by practical exercises in laboratories and simulators. The coursework includes marine engineering fundamentals such as fluid mechanics; thermodynamics; steam/diesel/gas propulsion systems; electrical and ignition systems; and management, automation and control of cooling systems. Students are exposed to approximately 27 h of face-to-face learning per week. The teachers of the school are divided into teaching teams based on their subject knowledge.

In the interviews with the teachers, we found that there was no common understanding of what was considered the right kind of knowledge to learn. Rather, the content knowledge in each module varied depending on the individual teacher, thus demonstrating that epistemic relations did not take a specific form but were stronger or weaker depending on the individual teacher. An initiative from management to have teachers adhere to a standardised plan in accordance with the new accreditation rules was met by statements such as 'It's hard to teach an old dog new tricks' (Hugh, teacher, machinist). Hugh continued: 'The whole mind-set needs to be reversed and it needs to be done slowly. The management has the impression that every time they get new ideas it equals success, but that's just not how it works. The teachers here are too old to be enthusiastic about small things'. This was echoed by several of the students who

explained that some teachers seemed reluctant to change their way of teaching: ‘The elderly who will soon retire just continue because it is difficult for them to change the way they have taught for 25 + years. There are perhaps 1 in 5 who do something about their teaching after mid-term evaluation’ (Peter, student, M8, metal worker). Willy (student, M6, UPS) believes that teachers’ pedagogical ideals are very age-determined: ‘Some of the young teachers are insanely structured and really have control over how it all should be so that it makes the best sense for the students. Then there are some who are just old-school: they just enter the classroom, tell a little about a subject that is not really structured or makes sense in relation to the course plan and the learning goals’ (Willy, student, M6). It therefore seemed as though there is a lack of clarity and consistency in what ‘counts’ as legitimate knowledge, skills and processes. Moreover, the institution did not use student feedback to ensure appropriate academic content and level, the right educational quality, etc.

### **Science or profession-oriented curricula?**

Some of the teachers explained that although they experienced students complaining about curriculum overload, not much could be done about it. For example, Hugh (teacher, machinist) explained his content was based on his own experience as a learner: ‘You learn many things that you might never use in real life, but you can also suddenly find yourself in a situation where it makes sense that you have this backpack with you’. Thus, in Hugh’s opinion, breadth and depth of learning were both achievable within the time allocated in the curriculum and his ideal was the marine engineer as a generalist. Another teacher, Simon (civil engineer), however, problematised how ‘the school wants to teach the students everything that they can risk coming across when they finish’. To him, the educational policies for post-secondary institutions were misinterpreted because curriculum expansion, he thought, was not the answer to the education now being designated as a bachelor’s degree (qualification framework level 6).

The students interviewed agreed that there was too much reading and that it was difficult for them to prioritise. They did not feel that the teachers’ curricular choices were giving them the full picture: ‘I think switching between so many subjects on the same day is hugely challenging because you go from something relatively complicated to something else complicated. *You* have to constantly adjust. I find that extremely difficult’ (Ray, student, M6/ M7, trained as a mechanic in the army). Another student explained: ‘Sometimes you feel that you are dyslexic. I do not think I am, but I think there are many who feel that when you read something, ‘what the hell is this about?’ I have always been able to understand what I read; it has never been a problem previously’ (Alex, student, M4). In their narratives, students also expressed how teachers competed for curriculum space and what should be included in the core curriculum. An example is Carl (student, M7, UPS; previously a student at a university where he missed something more hands-on), who described what in the specialisation plane (see [Figure 1](#)) could be an indication of both ER+ and ER- and signs of academic drift: ‘There are some subjects and its teachers where the syllabus is followed slavishly. In other subjects, teachers may have been out in the business world themselves, for example at a power plant, therefore sort according to what they feel the students will need to use after graduation’. The student data thus echoed that of the teachers that the target knowledge structure was



neither clear nor consistent. Rather, we see an indication of teachers' own backgrounds as having a large impact on what they consider the right kind of knowledge to learn.

### ***Legitimation of the 'right' kind of pedagogy***

As for the teachers' perception of the right kind of pedagogy, all teacher interviewees mentioned how ever-increasing class sizes led to fear of the depersonalisation of relationships with the students in the classroom. This indicates a declaration of preference of who the student is (in LCT terms, emphasising the knower's dispositions). However, there was no consensus on the balance between abstract disciplinary knowledge and previously held knowledge and experience. Rather, we again see how teachers' own educational biographies seemed to motivate a desire to replicate in the students what studying (marine) engineering had once entailed for them. Across disciplinary backgrounds, almost all teachers seemed to agree that repetition was a fruitful way of learning, thus indicating a pedagogical approach based on teaching to the test. This kind of teaching meant that students learnt that convergent knowledge was superior to divergent knowledge and that they needed to depend on their memorisation skills. For example, Sebastian (teacher, machinist) explains that his pedagogical approach was to 'get students to think for themselves by provoking, pushing, and teasing them and asking them to use their imagination'. Sebastian avoids PowerPoint, for which he received a good response in his mid-term evaluation. Instead, he 'draws a lot on the board and often makes some kind of cartoon'; the students then take pictures of this. To him, a problem with many of the students is that they only seek results and do not understand the process. Thus, whereas his ideal is to teach students the process of answering open-ended questions, what happens is that students manipulate existing knowledge by means of the provided example replicating his drawings on the board.

Luke (teacher, machinist) agreed with Sebastian that many students learn superficially. In his opinion, repetition helps the students—the more times they hear things, the better: 'I do everything on PowerPoint because then they have something afterwards they can look at. As I say to them, "in my PowerPoint is all you need to understand to be able to pass"', signalling that students should use convergent thinking and give correct answers to standard questions that do not require significant creativity. The difference between Sebastian and Luke is their ideal of what counts as the valid transmission of knowledge and whether the use of PowerPoint is a fruitful pedagogical device.

The desire for a pedagogy characterised by repetition and learning by rote was evident in the student body. Students Mike (M4, industrial technician) and Alex (M4, UPS) explained how they prefer teaching with a lot of face-to-face learning where the topic is repeated several times, although this was not always the case: 'Many of the things you really need to have repeated several times, but you only get it told once'. Thus, the students agreed with the teachers that repetition was an appropriate pedagogy.

### ***Developing particular sorts of knowers***

Most of the teachers seemed to have the same ideal about how to handle the differences in the learning capabilities of the students. This pedagogy focuses almost exclusively on those students who showed eagerness and willingness to learn despite their abilities,

based on the belief that knowers are made through the re-formation of their dispositions. It is through ongoing interaction with the curriculum that the target disposition is nurtured. This is known in Legitimation Code Theory as a cultivated gaze, which is a particular form of SR. For example, Sam (teacher, civil engineer) stated that he focuses exclusively on those who are struggling in the class ‘although there are too many of these types of students’. He is of the conviction that those who are good enough are able to get through on their own. He therefore rarely gives written assignments at home, as he believes that it often only benefits the skilled—they get it done—whereas those with problems only fall further and further behind when they cannot figure it out: ‘It is best instead to put groups together in class, where some have a good mathematical knowledge and others have good practical skills’.

Hugh (teacher, machinist) also experiences student diversity and, in his opinion, too many of the students ‘should not have been enrolled in the first place’. However, Hugh also legitimises social relations in his pedagogy by trying to create a conversation with as many people as possible, although some are not very committed: ‘I would rather spend 80% of the time on the 60% who want the education, as opposed to spending 80% of the time on the 20% who do not want it’. Hugh thus also evidences a conviction that what is required is a cultivated gaze, which can be taken on through students’ engagement in class. There is in his opinion no need to have an innate identity of personality in order to succeed. Hugh states, ‘I teach them that it does not matter that there are some small mistakes’, although he knows that some of his colleagues ‘think everything should be flawless at the institution’. This tension is also discernible in a quote from Ray (student, M6/M7): ‘They (the teachers) say there is no such thing as stupid questions, but there is because as soon as you say something, he may demean you with a joke or by saying “you have clearly not read, young man!”’ We see that although there may be differences among teachers on whether students should learn that there is only one right answer, they seem to agree that the focus in class should be on the students who show engagement and interest in learning.

All students interviewed agreed that there was a significant variance in teachers’ pedagogical skills and that students’ individual learner preferences ought to be more in focus in the teachers’ pedagogical approach: ‘The good teacher is the one that get all students involved and spend time on the ones who struggle. The poor teacher is the one that just reels off the stuff and have used the same teaching material for a long time’ (Ray, student, M6/M7). We see that Ray is calling for a pedagogy which would cultivate the necessary gaze in students. With his background as a trained mechanic in the army, he thinks that the machinists are the best teachers because they have more practical experience: ‘They have been out in real life whereas the engineer has been out in business, but mostly has been sitting and doing calculations—he may not quite know how it works, but he can read up on it purely theoretically, but we can do that ourselves. . . The civil engineers go into more detail whereas the machinists can sometimes be a little inconsistent and mention things that they do not return to’. That students give authority to the teachers according to their educational background and that this authority depends on the students’ own backgrounds is shown by Carl (the student previously enrolled at a university), who states that he personally learns best from those with a civil engineering background, as ‘they are the ones who can explain the most basic things’.

The potential struggles among the teachers due to teachers' authority being predicated on their educational background was also noticed by the students. Mike (student, M6) explained what he believes was 'a poor working environment and tone among the teachers', as they often slandered each other. An example of this was when the students moved from one semester to the next and were met with questions like: "Which teachers did you have before?" "We had XX." "Well, that's why you do not understand" (Mike, student, M6). The students' observations indicate that teachers' struggles in relation to epistemic relations and the consequences of academic drift mean that the institution lacks alignment on what should be considered the right kind of pedagogy.

### ***Bases for the legitimization of assessment***

The school struggled with a high exam failure rate. Mike (student, M6) explained how more contact between the individual student and the teacher can prevent students from failing and becoming stressed. He thus reiterates the extent to which a cultivated gaze is necessary for success. According to Mike, another measure to counteract the high failure rate could be contacting the student who has failed and teachers attempting to determine what made him/her fail. Currently, structural regulations make it difficult for the student to gain insight into the correct knowledge code: 'The problem is that if we have been to an exam then it must take 14 days before you have to talk to the teacher about that exam because of a complaint deadline. I think that is really nonsense'. As the school plans the re-examination soon after the initial exam, according to Mike, it is not possible for the students to replace the purely negative feedback with negative feedback incorporating future-oriented solutions.

The teachers, on the other hand, related the problem of many students failing their exams to what they perceived as the students' 'increasing instrumentalism'. Their experience was that students attempted to pick from the content what they thought was required for the right answer and whether this was something on which they would be examined. Interestingly, students seemed socialised precisely into this learning strategy as a great part of the teaching included calculating and students used arithmetic programs to do so. However, there seemed to be no alignment between what they were taught and the evaluative criteria. Moreover, the feedback they received was very scarce which is interesting given that the data suggests that the students need to take on a cultivated gaze to succeed. As Chris (student, M5, UPS) explained: 'If things are right you get a tick and if things are wrong you get a minus. It may be the student's own responsibility to seek an answer? Find out what it is that is wrong? I do not think teachers have time to give feedback. . . Sometimes before a re-examination the teacher invites everyone who has been dumped to attend a question hour. But you do not get anything corrected so you don't know what was correct and what was not in your own individual assignment'. Mike (student, M6) agreed and claimed that there are huge differences among teachers, whereby some spend time taking questions from students whereas others just say 'if you cannot do this exercise now, then you cannot become a machinist'. We therefore see that explicit evaluative criteria seem to be downplayed by most teachers and the evaluation of students' performance resides in criteria that are external to them.

Confronted with ways of providing students with input on how they are doing, Bob (teacher, electrician and machinist) explained that if he were to give students feedback on a regular basis, he would end up spending many hours doing so. He is, however, aware that the students love feedback and when he does give it, he can see an effect. He notices fewer errors in the next report, indicating that they have increased their learning. Another teacher, Otis (civil engineer), highlighted what could be considered as more or less explicit evaluative criteria when he explained how he uses the whiteboard a lot in his teaching to visualise what is in the books. While he thinks that a prerequisite for student learning is to give them feedback on what they do, the classes are too large for this to be realistic. Instead, they receive a copy of his solutions to the assignments.

### ***Assessment by identities***

Students of visible ethnic minority at this school relate a strong sense of being marginalised from positive learning experiences. It was also mentioned by some of the majority students, including some of the teachers, that there are many racists at the school and that several students have dropped out due to experiences of perceived racial discrimination. Ray (student, M6/ M7) explains his interactions with a teacher at the school: 'If you say something wrong, he would say, 'Jesus, did you not read a thing or do you not grasp anything at all?' That's how he talks to you. Or, for example, I was with two other dark people like me. We raised our hand(s) to get help with an assignment and then he sees that you have your hand raised, and then he says, 'Today, I just take a round' and he only addresses the white Danes and ignore(s) the foreigners. When he comes back to us, we have waited for almost an hour and during that period we have not been able to move forward with our exercise'.

Chris (student, M5) also mentions how individual learners' preferences are acknowledged in teachers' pedagogy and that these relate to students' ethnic backgrounds: 'There is a teacher who often comes up with racist jokes, which can be way too much when there are people with other ethnic backgrounds in the class. The other students laugh, but you do not know if they really think it's funny. One is not afraid to speak out against the teacher, but it should not be the case that there should be a need for it'. Another student, Mike (M6), confirmed this, having also experienced what he considered 'a rough tone in some teachers'. He further explained: 'The craftsmen are already accustomed to a rough jargon, but others are not and might think it's too much'.

Ray observes the emphasis on (particular) social relations when saying that a challenge for the institution is that many of the teachers are trained electrical engineers—but this means that those who enter as an electrician or UPS receive 'special treatment': 'They have a higher level when they start the education' and 'the teachers focus particularly on this type of student throughout the courses'. In general, Ray has the feeling that things are going too fast and that he is constantly behind: 'Always have the feeling of being lost. Cannot keep up and how can I get on track again?'.

Otis (teacher, civil engineer) explained his focus on social relations: 'I try to meet the students where they are. I have a very direct communication and I warn them about this. It also means that students respond in the same way. If the students make an effort to learn then I am willing to do a lot to help them'.

The fact that some students are privileged over others is also addressed in the teachers' narratives. For example, Hugh (teacher, machinist) explained how he is very close with some of his students and 'they can always contact me, as I do not think it is fair that students should be enrolled without we teachers taking care of them as human beings'. However, he further states that the management 'admit many clowns, which is irresponsible'. When asked to explain which students should be taken care of, Hugh replies:

It's about encouraging them along the way, also in relation to the fact that when they work well, they should be praised, like, "This is good work. You have made some detours, but you have thought well". Sometimes I also have to scold them a little and say "you simply cannot give me this".

We therefore see that the legitimacy of the 'right' kind of knower is conditioned by some qualities attributed to the learner (working well and not being a clown) prior to any kind of knowledge in itself.

From the data it seems that students are being assessed by some of their teachers on the basis of their identities. Thus, despite the data and the literature showing that the engineering field is a knowledge code (ER+, SR-), some students find they are negatively positioned by the SR their teachers bring to the assessment. In particular, it would seem that some of them are looking for a social gaze, whereby it is the (racial) social category that is used to position them in particular ways.

## Discussion

In this paper, our interest lay in why some students are more successful than others, in the context of the increase in students attending higher education over recent decades. Do specific practices support or constrain learning among specific groups of students? We found that the ideology and knowledge structures behind the epistemological core of marine engineering is a curriculum dominated by math and different forms of (marine) engineering science; however, its guidelines for solving assignments are not official and the modalities of interpretation are not objectivised as explicit criteria. Therefore, the topics were seen through the eyes of different marine engineering teachers and resulted in student learning challenges because of different opinions on which of the curricular topics should have the most emphasis. As argued by Wolff (2020, 181), the challenges in engineering education (and also in marine engineering) are exacerbated by 'blindness to the organizing principles of different forms of knowledge and the concomitant implications for teaching, learning and practice in context'.

We also found that the marine engineering teachers have various backgrounds and that they tended to valorise their knowledge specialty. This leads to 'silo' curricula (Wolff 2020), dependent on the individual teacher. These 'siloed' specialisations meant that students had difficulties translating the knowledge into the world of marine engineering work. According to Bernstein (2003, 52), pure disciplinary 'singulars' can be reconceptualised into 'regions' of professional knowledge that draw on multiple disciplines or fields in the world of work. He argues that regionalisation of knowledge requires the integration of specialisations rather than their collection (Wolff 2020, citing Bernstein 1977). In this school, we see a collection of forms of knowledge. According to Wolff (2020, 182), the curriculum ought to be facing both 'towards the disciplinary basis as

well as the world of work'. Achieving an appropriate balance between breadth and depth in curriculum content remains an unresolved issue in this school. Many of the teachers believe in repetitive teaching, although only a few explained how they brought concepts to bear on the students' experiences.

Indeed, as reflected in the study of Winberg et al. (2016), in this study many students found that many of the topics seemed unrelated to the integrative and dynamic nature of (marine) engineering.

As for the social relations practices of teachers, we found that some students observed that teachers became personal friends with students and that this occurred when the student signalled an effort to try and learn whereby a cultivated gaze was implemented. However, many of the students struggled with the overwhelming amount of information in the textbooks and they weren't sure how to separate critical knowledge from not-so-critical knowledge. According to the students, they needed more guidance through the material and for the important points to be made clearer.

Like other engineering programmes, marine engineering is based on a variety of pure and applied parts, where the pure parts (such as physics and mathematics) have 'a logic and coherence that is specific to the discipline and have clear boundaries between themselves and other areas of knowledge' (Winberg et al. 2016, 399). The applied parts are what students learn in the laboratories and simulators of the school. However, whereas vocational qualifications have offered general eligibility to pursue higher education, in this non-university institution, as found Lockett's study (2019), there seems to be contestation around the curriculum and how much practical experience should count in class.

We also focused on what counts as a valid realisation of this knowledge on the part of the taught. Assessment descriptions, rubrics, and learning outcomes send powerful messages to students about what counts as legitimate knowledge and are always open to varied interpretation by students (van van Heerden, Clarence, and Bharuthram 2017). However, in this study, the students are not seeing examples and/or are not engaged in assessment-related activities that make expectations clear. In this study we found that the basis for teachers' assessment of students did not always align with the official criteria. Rather, some students were assessed based on their inherent identity markers, that is a social gaze was implemented, rather than on the extent to which they had cultivated the disposition of a marine engineer. This was most evident when ethnic background, and the racism of some of the teachers, challenged the learning possibilities of those who did not fall into the group of white Danes. Thus, whereas learning goals emphasise knowledge as the only basis for grading, teachers also value non-knowledge factors such as students' characteristics, behaviour, and ethnicity. The differences were also related to the students' educational backgrounds and the teachers' educational backgrounds. In consequence, some students were positioned by teachers as inadequate learners, resulting in students feeling that they were stupid.

Some of the students did not experience success at transferring the key concepts of the knowledge taught into 'real life', which is the aim of educational policy reforms. This capacity to apply knowledge appropriately when it is framed in a new way is, according to Wheelahan (2007), at the heart of the concept of 'powerful knowledge'. However, as was found in other studies on students' self-directed learning, in this study students'

habits were predominately surface (or rote-learning) approaches and rarely deep and strategic approaches (Vermunt and Van Rijswijk 1988).

The enrolment in the marine engineering bachelor programme has grown in number and heterogeneity, which has led to a discourse of deficiency wherein some students are less prepared for academic study in comparison with the more selected intakes of previous systems (Lillis and Turner 2001). We cannot conclude that the students with a skilled trade background are less prepared for non-university higher education than their UPS counterparts. Nonetheless, due to the large emphasis on electric systems, electricians seemed to have an advantage. Since vocational programmes have been steered to a large degree by the business sector, with a focus on employers' interests, our data does not allow us to say whether this has changed over time.

We found that most teachers seemed primarily to require students to recall facts, which has been found to be typical for science teachers (Lee and Kinzie 2012; Eliasson, Karlsson, and Sørensen 2017; Lord and Baviskar 2007; Biggers 2018; Childs and McNicholl 2007). This means that the students risk only constructing superficial memorization and do not engage in a meaningful, in-depth approach to science. Systematic and sequenced shifts in the degrees of complexity form a key aspect of building knowledge in classroom practices (Macnaught et al. 2013; Maton 2020). Although some of the teachers in this study mentioned how they wished for their students to develop a capacity for critical thinking, the concept is rarely precisely defined and teachers often do not have explicit criteria for assessing the level of critical thinking (Fisher 2003).

## Conclusion

In this study, many teachers characterised the knowledge principles by which marine engineering students are expected to orient themselves as having a low level of scientific literacy, whereby marine engineering science is seen as factual knowledge to be memorised. For these teachers, achievement gains are measured by the frequent use of tests during classroom teaching, with the focus on convergent rather than divergent thinking. However, other teachers wish to promote critical thinking in students. Thus, whereas all teachers emphasised epistemic relations as central to achievement, as a newly classified non-university higher education institution, they had various educational backgrounds and their pedagogical ideals were related to their backgrounds. Therefore, the legitimated structure of knowledge was unclear to students.

Students also had diverse backgrounds, with some students possessing legitimation codes (measures of achievement) that matched the codes dominating this particular educational context and others experiencing a clash between the codes of the educational institution and those dictated by their background. In this school, most students came from trade skills. To them, meaning is dependent on the social context. However, there was no consensus among teachers on whether students' dispositions should be emphasised as the basis of legitimate insight. Therefore, students embodied competing claims to legitimacy and what should be considered the dominant basis of achievement to gain academic success. Regarding social relations, those whom all teachers privileged and considered as the high-end students were those who were very good at maths and displayed an interest in the class. Whereas this cultivated gaze could increase the potential for wider access for more diverse groups of students, social hierarchies were also

established based on more than education alone. Especially among ethnic minority students, there was a sense of student alienation as they were exposed to racism from some of the teachers. The social gaze restricted legitimacy to social categories that were impossible for them to join. This resulted in disengagement among these groups of students and increased drop-out rates. Thus, while there has been a significant turn towards ‘diversity’ as a way to define the social and educational missions of universities in Western countries, what students and teachers experience in this school does not match with aims of the educational policies targeting widening participation and diversification.

In this type of non-university higher-education institution, the enrolment requirements regarding relevant occupational practice have been reduced, and theoretical parts of the curriculum have been increased at the expense of more practical elements. However, due to struggles among teachers on what should be the ‘right’ kind of knowledge to learn and who the ‘right’ kind of knower is, a more explicit structuring of the curriculum and an explicit introduction to the expectations of students in the courses of the school is necessary to address student retention.

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## Conflicts of interest

None declared.

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No potential conflict of interest was reported by the author(s).

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