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Abstract

This paper examines the practice of collision avoidance in Merchant ships to highlight the role of tacit knowledge and collective learning in the formation of professional practice. Analysis of 1,431 recorded VHF radio conversations drawn from real-time ship-to-ship interactions provides a unique window onto professional competence in navigation, and the application of professional judgement underpinned by tacit knowledge learned *through* practice. Moreover, we argue that such tacit knowledge is gained within a 'community of practice'. More specifically, our data reveal how: (i) the practice of collision avoidance is more collaborative than reference to the extant regulations (the COLREGS) alone would suggest, and (ii.) the practice of discussing collision avoidance over the radio can be seen as a form of collective production and learning of tacit knowledge through practice. Consequently, our analysis provides insight into the social nature of collision avoidance practice. In so doing, the paper makes a significant contribution by (i) adding a new example to the corpus of research in this area, (ii) introducing the community perspective of learning to the maritime sector, (iii) extending the concept of community-based learning by presenting data that illustrates both individual and collective learning.

Keywords: Workplace Learning; Communities of Practice; Tacit knowledge; Collision Avoidance; Maritime Training

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What is your intention? Tacit knowledge and community-based learning for collision avoidance in the global maritime industry

1. Introduction

A collision between ships is both economically costly, environmentally damaging and presents a danger to life. Safe navigation across the world's shipping routes requires both knowledge of international collision avoidance regulations (the COLREGS) and their effective application. The skilled navigator works through and with ambiguities, in concert with others, to sustain safe passage; with such professional literacy captured in the term 'good seamanship'¹ (COLREGs Rule 8a). The demonstration of such exhibits mastery of both the formal and tacit knowledge and norms of this community. How learning takes place to acquire this level of competence is however under-researched. We address one aspect of this deficit by examining the acquisition of tacit knowledge necessary to practice successful

collision avoidance, as it is displayed in VHF radio communications between ships' officers discussing collision avoidance action.

It is our contention that examination of this naturally occurring radio talk reveals what is tacit in the practice of inter-ship collision avoidance; more specifically, what it is to act according to the precepts of 'good seamanship'. Further, we argue that the interactions made visible via analysis of this radio-based communicative order can usefully be viewed from the perspective of community-based learning (Lave and Wenger 1991). In this case, the community of practice is one that is transient, informal, and is distributed beyond the bounds of the ship. Considered from this perspective, the talk provides both a window onto the underlying interactional processes and contributes to the development of community norms and identity formation as navigators learn to act in a 'good seamanlike' manner (i.e. as a 'good' or 'expert' navigator would). That is, examination of the data makes transparent the previously hidden (tacit) reasoning-in-practice and the social nature of collision avoidance that underlies this learning in practice, with implications for navigator training.

A complex literature on understanding workplace learning and professional practice has emerged over recent decades (Hager and Beckett 2019, Nicolini et al 2022). This has included a variety of sociocultural theories which have brought the diverse social aspects of learning to major prominence. Important threads within this developing literature include situated learning, cultural-historical activity theory, actor network theory, and post-structural theories. None of these broad theories has achieved dominance. Rather, ongoing critique, both internal and external, has seen them continuously evolve and develop new strands (e.g. Malloch et al. 2012), and this remains an area of considerable debate and contestation.

One such contested issue concerns the role of individual learning as against group learning. Lave and Wenger, pioneers of sociocultural theorising, maintained that 'all learning is social'. But as Salomon and Perkins (1998) argued, in a classic review article, this is a highly ambiguous claim. They identified six "distinctive meanings of social learning" (Salomon & Perkins 1998: 3). However, only two of these recognise the possibility of group learning. The first account of group learning draws on Lave and Wenger's seminal (1991) text, dubbed the 'sociocultural' approach and consists in learning arising gradually from participation with others in a context of practice.

The sociocultural approach is, however, often discussed as if it only encompasses the learning of individuals. This is understandable given Lave and Wenger's focus on apprenticeship based learning, and the trajectory of novice individual's to becoming full participants in a community of practice. And, because most traditional learning literature assumed that all learning is individual learning.

The second meaning of social learning, according to Salomon and Perkins, involves learning by groups, and refers to theories where the main focus is squarely the group as the entity that learns (e.g. 'teams, organizations, cultures, or other collectives' (1998: 5)). Here they single out sociocultural activity theorists (e.g. Cole and Engestrom 1993), with their grounding in psychological and organisational theory. It could be questioned whether these

two meanings of social learning are genuinely distinct. However, the crucial point from our perspective is that sociocultural learning theories have brought the notion of group learning to prominence, together with the idea that much learning outside of formal settings is of this kind.

In the workplace learning literature some write as though individual learning is no longer a relevant concept (e.g. Cole and Engestrom 1993). Others, recognise the important social aspects of learning but maintain that group learning is reducible to the sum of the individual learnings of the group members (e.g. Eraut 2000). In contrast, a third group view both individual learning and social learning as distinctive, real phenomena (e.g. Hager and Beckett, 2022). In presenting our data this paper seeks to add support to the latter perspective.

Through the presentation and analysis of our unique dataset we focus on the practice of navigation and collision avoidance to provide insight into the role and acquisition of tacit knowledge central to this practice. In so doing, we provide an example of ship's navigators learning to do collision avoidance, both individually and as a group, where the group learning is both distinctive from and not reducible to the former. Hence the paper provides an empirical example to support the idea of an expanded domain of learning that involves both individuals and groups (in particular, groups comprised of spatially distributed actors with limited contact). Moreover, in demonstrating the social nature of collision avoidance, the paper seeks to demonstrate the social nature of learning as relevant for maritime training.

2. Inter-ship collision avoidance

Maritime shipping is responsible for transporting 90% of world trade (IMO 2018a). With large modern ships costing more than 150 million USD (ME 2015), a navigational error can lead to disruption to the supply chain, financial and reputational loss, and, crucially, loss of life and significant damage to the marine environment. Hence the safe navigation of merchant ships is a crucial, time-critical, and high-risk activity (Author A 2006). To this end, the International Maritime Organisation (IMO) established regulation governing how ships should behave when encountering another vessel where risk of collision exists; namely, the Convention on the International Regulations for Preventing Collisions at Sea, 1972 (known as the COLREGS).

Central to the development of the COLREGS is the internationally accepted principle of non-interference with ships plying their trade and reliance on the good judgement of the professional mariner to ensure the safe passage of the ship; a notion embedded in international maritime law (Plant 1996). As such, while broadly prescriptive, the application of the rules allows for a wide range of possible specific manoeuvres in any given situation (Stratheros, et al. 2008). Essential to the successful application of the COLREGS is the ability to anticipate how others will act and respond appropriately. This requires the ability to read the context (Chauvin and Larjdane 2008) and apply effective practical judgement. A key component of this ability to read the context is the act of clear 'intention signalling' by the ships involved (COLREGs, Rule 8). That is, by their manoeuvre, ships need to indicate what

action they are taking. How and when they do this, i.e. in a manner that reduces uncertainty, is part of what it is to demonstrate good seamanship.

Importantly, the collective act of safe navigation requires this set of competencies across all the practitioners to ensure systematic coordinated action. In essence, professional competence (i.e. the practice of 'good seamanship') is not simply the application of knowledge *to* practice but the application of sound judgement in practice, underpinned by tacit knowledge learned *through* practice.

It is the practical accomplishment of this key concept, action in accordance with 'good seamanship' (notably not defined) that we highlight through the presentation of our data. We argue that this notion is fundamental to the application of the rules and yet receives little, if any, attention within formal training institutes. Indeed, our point is that it is a form of tacit knowledge that is necessarily learned through practice.

Tacit knowledge and Learning

Several authors, notably Dreyfus and Dreyfus (1980, 1986) and Lave and Wenger (1991), have developed models of learning that describe learners moving through a series of stages from novice to expert as they progress from rule-governed behaviour to reliance on experience and tacit knowledge. In brief, novices consciously learn to apply rules in a 'context-free' situation, whereas experts fluently act in complex real-time concrete situations. That is, through experience learners become less reliant on maxims to guide behaviour and increasingly fluent in their ability to 'see' how to act in complex scenarios. For the expert, action becomes intuitive, and contexts are perceived holistically. But unlike Dreyfus and Dreyfus, for Lave and Wenger, expertise is increasingly socially-constituted.

Critiquing the account of Dreyfus and Dreyfus, Dall'Alba and Sandberg (2006) note that professional learning is not purely individualistic. Rather, following Lave and Wenger (1991), they highlight the social nature of learning and the importance of learning by participating as part of a community in work activities. For Lave and Wenger (1991) learning is transformed from an essentially epistemological issue to an ontological one. The concern ceases to be with what is going on inside an individual's head and instead focuses on the social nature of learning and issues of identity transformation. Drawing on the features of apprenticeship-based learning, including becoming a quartermaster aboard a naval ship, they argue that learning needs to be seen through the lens of participation in the activity to be learned, located within a community of practitioners. Central to their account is the idea of a trajectory from novice to expert; newcomers to work groups learn by under-studying more expert practitioners. Novices initially engage in peripheral activities and through broader participation progress to full participation in the community of practice, with a consequent change in identity from that of novice to master. In such a context learning involves learning how to become like the expert, how to be a practitioner, and so involves learning the wider social values, beliefs, and ways of acting. The analytic focus ceases to be individuals and their cognitive processes and becomes social practice and how individuals in the group are able to participate (Lave and Wenger, 1991).

The lens of community of practice has been utilised to examine learning in multiple professional contexts, including, nursing (Melia, 1987) and teaching (Viskovic, 2006). Navigator training has been characterised as a form of quasi-apprenticeship (Gould, 2010) with learning distributed between the classroom and time spent understudying a qualified officer. Hutchins (1995) in his book on distributed cognition, likewise, discusses learning within a navigational team aboard a military naval vessel as a form of community-based activity, with individuals progressing through a hierarchy of roles. While initial training of navigators appears to fit well with this concept of community-based learning our concern in this paper is with qualified navigators and what we claim is ongoing practice-based learning derived from performing navigation in real-world high-risk situations.

The concept of community of practice (CoP), as developed by Lave and Wenger, has been widely critiqued, in part for its over-emphasis on novice training (e.g. Hodkinson & Hodkinson, 2004; Fuller & Unwin, 2004; Fuller et al 2005) and its vagueness and diffuse application (e.g. Fuller et al, 2005; Gherardi 2009; Li et al., 2009) in part due to a divergence in the literature between 'academic-oriented' and 'management focused' prescriptive approaches deriving from Wenger's later management consultancy work (e.g. Wenger and Snyder 2000; for a detailed review see Nicolini et al 2022).

Lave (2019), revisiting the concept of 'communities of practice', argues that it has been misunderstood "as homogenous, shared bounded groups" when it was conceived as "a nexus of ongoing cultural practice and as composed of its changing participants" (p.140). That is, learning doesn't necessarily take place in a linear manner with a transition from novice to expert but is a much more contested and uneven process with individuals participating in social practices in different ways, and across different areas of life. Hence, she writes: "A community of practice is a condition of possibility for learning" (p.140). To emphasise the point, she suggests thinking in terms of '*Textured landscapes of possibility*' for learning-in-practice (p.147) and argues that researchers need to 'decentre' the focus of their attention from individual learning to the wider social practices of which learning is a part (p.148). This re-statement of intent, however, leaves in place the central tenet of the approach, which is the changing nature of participation in social practice. And, as noted above, Salomon and Perkins stress that this approach also implies that the community of practice itself, as an entity, learns over time.

In a similar vein, Nicolini et al (2022), referring to the work of Brown and Duguid, write:

CoPs refer to the people involved in interactional and conversational activities...to jointly construct meaning that unfolds around practical challenges and enables learning-by-working (p684).

In presenting our data and analysis, we argue that ships' navigators aboard different ships mutually engaged in collision avoidance activities satisfy this description. The practical challenge is avoidance of collision. All involved in the interaction work to the same end and do so by reference to the COLREGs which give meaning to their actions and allows for learning to take place both within individuals and across the group. Moreover, as Hutchins's (1995) work on navigational decision-making aboard ship demonstrates, navigation is

accomplished within the bridge team with expertise distributed across the group but also the 'technology and the practices that unify them' (Guile and Unwin, 2022: 34). The point is that knowledge does not necessarily inhere in any given individual but is rather located in the different elements constitutive of the social practice, including for instance, AIS and radar displays, rudder indicators, compass bearings, and navigational charts.

From an analytical perspective, there are two key elements that we take from this approach. The first is the recognition that important elements of learning take place in a social context by members engaged in a shared activity. The second is that such learning within individuals and the group is about inculcating and developing shared values and norms as much as acquiring technical understanding (Beckett, 1996). Our concern, however, is with the latter, i.e. learning to act in a professional manner as a 'good' professional 'seaman' would. This involves learning '*through participation*' (Eraut 1994, Gherardi 2006) within a community of practitioners. And, importantly, where learning may take place across the group over and above the participating individuals.

4. Maritime Regulation and Training

Well trained officers are essential to the safe and efficient operation of the world's merchant ships (EMSA 2018). Officer training takes the form of periods at college, learning codified theoretical knowledge, followed by time spent at sea learning on the job – the combination of such is designed to achieve a level of professional competence (ILO 2004). That is, it is based on a mix of formal learning (*learning about*) and practice-based learning (*learning through*) (Gibb 2002). The latter fits with Lave and Wenger's concept of learning through participation in a community of practice. Trainees (cadets) learn to become Deck Officers or Engineers by becoming socialised into the routines and norms of the work and life of a deck or engineering officer. The significance of time spent onboard undertaking real-life tasks in the company of qualified others is captured by the need to maintain a record book of activities undertaken, as specified in the 'Standards of Training Certification and Watchkeeping Convention' (STCW) (Reg. II/1 para 2.2). Whilst a record must be kept of activities undertaken, this does not capture the learning involved, particularly the tacit knowledge gained in such contexts. Examination of our data provides insight into one such activity, the practice of collision avoidance as revealed in inter-ship radio communications. The recordings were made following the introduction of a new shipboard technology that facilitated such communications.

In 2004 the carriage of a new Automated Identification System (AIS) became mandatory. It provides navigating officers access to the names of nearby vessels, which has afforded the opportunity to communicate by VHF radio (Hutchby 2001). Prior to this development, contacting other ships by radio was a time-consuming and risk-laden affair, that involved attempting to identify them by reference to their geographical location (Author A 2008). The ease of identification afforded by AIS led to significantly increased use of radio communication for collision avoidance in the years immediately following its introduction. Analysis of such radio conversations offers new opportunities to investigate the application of the COLREGS for understanding collision avoidance practice, the nature of professional practice more generally, the expression of tacit knowledge, and the content and practice of learning.

In the following sections, we outline the data collection methods and refer to formal learning of the COLREGS, before providing detailed analysis of radio conversations between officers engaging in collision avoidance in practice that highlight the tacit dimension of learning and its role in the formation of competent officers.

5. Methods

The arguments presented in this paper draw on a dataset of naturally occurring VHF radio conversations collected as part of a programme of work funded by the Lloyd's Register Foundation. For a week in October 2004, following the introduction of AIS, two researchers based at the Dover Channel Navigational Service (CNIS) monitored channel 16 (the international listening and calling channel) of the VHF radio 24 hours a day for seven days. Conversations were followed as callers moved, after making contact, from channel 16 onto the chosen 'working channels'². Hand-written (verbatim) notes were made of the conversations. Ships were also observed on radar and, where clearly identified, small sketches were drawn of the relative position of the ships. This exercise was repeated in 2005 and 2007³.

Thematic analysis was undertaken, and the conversations grouped according to the main aim of the communication (Braun and Clark 2006). Three principal categories were identified: to exchange general information, for social chat and to discuss collision avoidance – the latter formed the largest category (92%). Conversations concerned with collision avoidance were then further analysed and coded, by hand. Key categories to emerge were confirmation seeking, challenges, rebukes, contestation, and collaboration. Interpretations also considered the associated sketches to aid sense-making.

The analysis is further informed by several decades of research in the maritime sector. Additionally, one of the authors can draw on autobiographical experience of being a Master Mariner and external examiner at several UK maritime education training institutions.

6. Training and the application of the COLREGS in principle

At the core of the COLREGS is a 'right of way' principle and the privileging of certain types of ships (Plant 1996). By prescribing how vessels should behave in an encounter they serve as a risk management protocol (Baladuf, et al. 2011). A key part of deck officer training, governed by the STCW Convention, is competence in the application of the COLREGS (Sect. A-II/1). Within maritime education and training centres, seafarers acquire knowledge of the detailed contents and the principled application of the COLREGs which prescribe how vessels within an interaction should behave. Each vessel is ascribed a role by the regulations determined by its relative position to the other. With each role comes a set of obligations, principally, to keep clear of the other vessel or to stand-on (i.e. continue as one is going). In addition, the rules also require that navigators make clear their intentions by taking action that:

[I]s positive, in ample time and in accordance with due regard to the observance of good seamanship (Rule 8).

This section is under-specified in comparison with the previously mentioned directions as to how to act. What counts as positive action is given some degree of substance in terms of avoiding small incremental changes, but what it means to act in 'ample time' or in accordance with 'good seamanship' is not elaborated.

It is this key concept, action in accordance with 'good seamanship' and the learning necessary to instantiate such behaviour (including, taking positive action in ample time) that we highlight below. We argue that this notion is fundamental to the application of the rules and yet is the aspect that receives little, if any, attention within formal training institutes. Indeed, our point is that it is a form of tacit knowledge that is necessarily learned through practice and is context specific and constitutes an ongoing accomplishment amongst the community of navigators.

7. Radio Discussions and the Application of the COLREGS in Practice

Prior to the requirement to carry AIS aboard all ships in 2004 identifying a nearby ship for the purposes of radio communication was a complex affair, carrying significant risk of misidentification (Author A 2008). By providing navigators with access to the names of such ships, AIS has afforded the opportunity to establish radio communication much more easily (Hutchby 2001). This affordance led to significantly increased use of radio communication for collision avoidance that has important consequences for understanding existing practice, learning, and training. Our data showed both an increase in calling frequency (from 12.5% (2004) to 20.8% (2007); 89.4% of which related to collision avoidance (Author A 2008). It is worth noting at this point that the UK Maritime and Coastguard Agency (MGN 324) advised against the use of VHF radio to discuss collision avoidance due to the risk of misidentification, confusion over what has been agreed, and delays in acting. Instances were identified within our data to support each of these claims. The focus of this section however is the content of the discussions and what it tells us about navigational decision-making.

Analysis of the radio conversations revealed how: (i) the practice of collision avoidance is more collaborative than reference to the COLREGS alone would suggest, and (ii.) the practice of discussing collision avoidance can be seen as a form of collective production and learning of tacit knowledge through practice. In the following sections we present examples from the recorded radio conversations to explore how seafarers apply the rules and make sense of the situation confronting them; in this way we identify how learning *through* practice mediates the relationship between formal knowledge of the regulations (COLREGS) and their application, and professional competence in applying them in real life contexts. In presenting the examples we use the convention of referring to the stand-on vessel as Ship-C (Continue) and the give-way vessel as Ship-A (Action)

7.1. Communicating Intent

The COLREGS were introduced to reduce the risk of collision by providing a clear framework for action to be taken, where risk of collision is perceived to exist; thereby reducing uncertainty and hence risk in ship-to-ship interactions.

Authors have investigated the practical accomplishment of interactions between road traffic, and pedestrians and road users. A key feature identified is 'intention signalling'

which may be achieved by means of a variety of actions. Standardly, for vehicle interaction, this involves the use of an indicator light, but researchers have also described how the use of horn-beeping, light-flashing (Laurier et al. 2020), a wave, a look (Smith 2018) can be used to achieve signalling in interaction. In the case of ships, this is primarily achieved by manoeuvring the ship. With the advent of AIS, the use of radio communications has become an additional means of signalling.

However, the data show that the most common reason for inter-ship-communication is to seek reassurance (i.e. confirmation) that the vessel called will act as required by the regulations. Such calls can be seen as commensurate with the use of the 'confirmatory form' utilised between officers within navigational teams aboard ship (Author A 2006) and navigators and port authorities (Froholdt 2016) to reduce risk of miscommunication. The standard way of expressing concern at a perceived lack of action is in the form of a query 'What is your intention?'⁴ as can be seen in the following examples.

The first three examples involve vessels in a Crossing situation; as such, Ship-A should turn to starboard (i.e. to the right) and pass astern of Ship-C (Rule 15).

Example 1

1. Ship-C: What is your intention? Will you pass my astern?
2. Ship-A: Yes sir, that's our intention to pass astern of you.
3. Ship-C: Thank you, back to 16. [#308]

In this case, the stand-on vessel (Ship-C) initiates the call and seeks clarification from the give-way vessel (Ship-A) as to whether it intends to take the required action and alter to starboard and pass around its stern. In so doing, the navigator aboard Ship-C exhibits a lack of confidence in the navigator aboard Ship-A to act appropriately, there is a tacit questioning of the professional competence of the other. Ship-A accepts the right of Ship-C to challenge them and simply confirms that they intend to take the required course of action, thereby removing the uncertainty and presumably alleviating the anxiety of the officer aboard Ship-C – who closes the conversation with the standard call-ending of 'back to 16' (the international calling and listening channel).

What is apparent from this case is that exchanges are very brief and to the point, reflecting the medium of communication and the time-critical nature of the activity, but also that the participants are engaged in a shared activity with an underlying narrative that informs their general sense-making (Harré and Langehoven 1999), that is they orient their conversations to the COLREGs. At the same time, it points to the fact that the expectations of when it is appropriate to act and alter course is perceived differently by the two officers, arguably reflecting differences in their interpretation of what constitutes timely action and hence 'good seamanship'.

7.2. Questioning as learning

Several authors have identified the active nature of learning, and that a prominent feature of learning practice is having inadequacies or failings identified as a basis for improvement (Billett 2001, Eraut 2000). In examples 2 & 3 we see seafarers 'challenging' each other and highlighting ways in which actions fall short of what is deemed appropriate behaviour. In

example 2, the stand-on vessel again initiates the call but is more assertive; rather than inquiring as to the give-way vessel's intention, the officer makes clear that the expectation is that Ship-A should alter to starboard.

Example 2

1. Ship-C: What is your intention? You are not complying with safety regulations,
2. you have to alter course to your starboard side.
3. Ship-A: OK, OK! Back to 16 [#260]

The competence of Ship-A is challenged with the claim: "You are not complying ..." Likewise, in example 3, the usual formality of 'What is your intention?' is ignored and instead the question is posed 'When do you plan to alter to starboard?' The implication is clear that action is overdue. The response received, 'I alter just now', is not accepted as evidence of competence and draws further rebuke as it is pointed out that failure to alter would lead to a crossing distance of 0.3 nautical miles which is not deemed to be sufficient, i.e. it is not good seamanlike practice.

Example 3

1. Ship-C: When do you plan to alter to starboard?
2. Ship-A: Just now I alter to starboard
3. Ship-C: Yeah please, cause 0.3 (passing distance) is not enough. It is not enough.
4. Ship-A: I alter to starboard. 16 (VHF Channel) [#305]

In both cases, it is explicitly pointed out that Ship-A has failed to exemplify the characteristics of good seamanship. The fact of the call highlights that the generalised assumption of professional competence necessary to the 'confident and fluent' flow of inter-ship interaction has been withdrawn.⁵

7.3. Contestation and knowledge claims

Not all challenges go uncontested. In example 4 the difference in perception is made visible; the give-way vessel, when challenged, clearly indicates that they assess the situation to be safe. In response to the query 'you pass my stern', Ship-A acknowledges that this is their intention, since that is what the regulations require.

Example 4

1. Ship-C: You pass my stern?
2. Ship-A: Yes, according to the COLREGs, safe passage.
3. Ship-C: You pass to my aft?
4. Ship-A: Yes, according to the Collision Regulations.
5. Ship-C: Thank you have a good watch. [#35]

When Ship-C seeks further reassurance (line 3), the officer aboard Ship-A replies by repeating the previous answer - but this time spelling-out the reference to the collision regulations in full; thereby positioning themselves as authoritative (Van Langenhoven and Harré 1999) and possessing superior knowledge of the regulations. In so doing, they reject any implication of negligence in the timing of their manoeuvre and warrant their assertion with a knowledge display (Goffman 1969) by making explicit reference to the COLREGs. This

example highlights the vagueness inherent in the rules and draws attention to the contestation and norm forming implicit in these conversations.

Through challenges, rebukes, and rebuttals, seafarers publicly question and account for behaviours based on action to be taken, perceived danger, and reference to established guidance. The exchange further indicates a challenging of professional competence; collision avoidance is stilted, achieved via verbal confirmation, rather than a confident and fluent interaction, grounded in silent rule-following and a generalised assumption of competence within the community. In the process, individuals are provoked to view themselves and their actions in terms of professional competence.

7.4. A lack of confidence? Seeking support and sharing the responsibility

In communities of practice, the novice learns by initially undertaking peripheral activities and through mentoring or supervision increasingly takes on more challenging tasks. With this progression comes skill, 'confidence and fluency in performance' (Eraut 2010). Our argument is that VHF communication reveals that even though professionals may possess formal knowledge of the COLREGs and their application, the indeterminacy at their core means that application requires critical reflection and reasoning in practice and that this is worked out *in-practice* in interaction with others. As such confidence and fluency in interaction can be seen to be grounded in tacit knowledge of 'how to proceed' in a professional manner. What the above examples highlight is the *normally taken for granted* made visible due to an apparent failure of good practice and the withdrawal of confidence in specific others. In the following examples, we further see the complexity and interactional work involved in applying the rules - not in contexts where there is a perceived failure and an attempt to 'repair' the situation, but where the need to talk was less apparent.

In examples 5 and 6 we see the ship required to act (Ship-A) calling to inform the stand-on vessel that they planned to overtake. In accordance with the COLREGs, the onus is simply on the overtaking vessel to keep clear.⁶

Example 5

1. Ship-A: I am going to overtake you on your starboard side.
2. Ship-C: OK you can overtake. [#25]

Example 6

1. Ship-A: I am overtaking you on your port side.
2. Ship-C: OK, go ahead; I will maintain my course and speed. [#73]

In both these cases, the overtaking vessel signals its intention and, in so doing, seeks reassurance (confirmation) that it is 'OK' to carry out their manoeuvre. Such action serves to make the other aware of their presence and to ensure that they would not undertake a detrimental manoeuvre, rather than maintain their course and speed as required. The effect is to make explicit the reflection-in-action involved in achieving a safe passing. Further by agreeing to the action, the officer aboard Ship-C, in each case, is effectively 'approving' the manoeuvre; thereby acknowledging the legitimacy of the action and affirming their role in it, as part of a joint action. In contrast with the earlier examples of contestation and rebuke,

such behaviour can be seen as a form of supportive behaviour with tacit judgements and concerns – normally hidden - being made visible.

What each of these examples points to is that decision-making and the development of practice, in terms of how to apply the encoded knowledge in the rules, becomes distributed and worked out in public amongst a community of professionals.

7.5. Cooperation to develop solutions

The previous examples make visible the tacit knowledge underpinning decision-making in applying the COLREGS, as we can see seafarers work through the application of the rules in what are reasonably straightforward, if risk-laden, navigational encounters. However, the data also reveals situations of increased complexity. These cases highlight how the community of navigators operate with a shared focus on ensuring safe navigation that involves collaborative action that goes beyond, and may even conflict with, the codified knowledge contained within the COLREGS, but can arguably be seen as the practice of good seamanship.

The collaborative nature of many of the conversations can be seen in the following examples. In example 7, for instance, two vessels meet head-on and are subject to Rule 14 - requiring each to alter to starboard and pass, port-side to port-side, or red-light to red-light. As both ships are required to take action, they are referred to as A and B. Ship-A initiates the call and proposes 'green to green', i.e. that each alter to port (turn to the left), contrary to the regulations. This is challenged by Ship-B, line 2, where it is pointed out that normal behaviour requires 'red to red' (i.e. turning to starboard / the right). In this instance, however, Ship-A points to the fact that there is another ship on their starboard (right hand) side, the implication being that to alter to starboard would put them in a difficult position relative to that ship. Accepting this account and the dilemma faced by Ship-A, Ship B agrees to the alternative action (line 4).

Example 7

1. Ship-A: OK green to green?
2. Ship B: Why green to green? Red to Red!
3. Ship-A: I have a small ship to starboard side.
4. Ship B: OK, green to green. [#304]

Likewise, in example 8, the two officers again coordinate their actions in recognition of the presence of a third vessel to achieve a safe outcome for all.

Example 8

1. Ship-A: I would like to overtake you on your starboard side; I would appreciate it if you could give me a couple of degrees to port because I have one more vessel on starboard side.
2. Ship-C: OK no problem I will go to 015. Go ahead.
3. Ship-A: Thank you. [#79]

As in previous examples, Ship-A initially calls-up seeking permission to overtake. In addition, it requests Ship-C take action contrary to the COLREGS; which it agrees to, on the basis of the close proximity of a third vessel that imposes a restriction on Ship-A's ability to manoeuvre.

What we see in these cases is the explicit recognition of the real-life complexities of navigation and collision avoidance in multi-ship scenarios. The navigator in acting in accordance with the practice of good seamanship is required to recognise and accommodate the relevance of factors beyond the immediate interaction. Direct appeal to the substantive rules cannot support this action, rather the underpinning justification is acknowledgement that good practice sometimes requires flexible interpretation of the rules (arguably rule breaking). The justification is 'good seamanship'. This goes beyond learning the codified knowledge and its application as contained in the COLREGs. Rather, these conversations make visible the reasoning and collaborative nature of collision avoidance that typically takes place, even when not explicitly spoken. Navigators, in the performance of and learning about good seamanship, constantly anticipate and act towards, and on behalf of, others in real-time, dynamic, and risk-laden situations - a feature also observed in a quantitative study of ship interactions and passing distances, where it was noted that ships being overtaken in a narrow channel would typically move closer to the edge of the channel to allow the passing vessel more space (Shu et al. 2017).

Hence it is our contention that the data presented demonstrate learning *through* practice of the tacit knowledge encapsulated within professional competence. In the process of seeking confirmation, challenging, rebuking, accounting, and collaborating, these officers through their conversations-in-interaction are engaged in creating norms and acquiring tacit knowledge of what constitutes professional competence, i.e. 'good seamanship'. And, importantly, such behaviours involve more than the mere sharing of information but involve affective and volitional elements, including matters of confidence, trust and stress, and the need to act. That is, learning in this context can be seen as broader than mere cognition and involves the whole person. Moreover, with the advent of AIS, these practices take place in a different and revised communicative landscape.

8. Discussion and Conclusion

Navigators aboard the world's merchant vessels routinely engage in time-critical, high-risk interactions which are mediated by internationally developed and certificated navigator training; specifically, training in the COLREGs - the formal rule-based system intended to reduce the risk of collision. However, central to the COLREGs is an often overlooked and inherently vague concept, that of 'good seamanlike practice'. This idea of professional competence is central to the successful application of the regulations but cannot be systematically codified and must be learned *through* practice in interaction with relevant others.

With the introduction of AIS, a significant proportion of seafarers are seeking recourse to the radio to discuss collision avoidance, rather than directly interpreting, and applying the formal codified regulations. It is our contention that analysis of these conversations both provides insight into the tacit knowledge embedded within these ship-to-ship encounters

and demonstrates its production-in-interaction. That is, we have argued that in the analysis of these conversations, understandings of what constitutes appropriate behaviour are (i) made visible, (ii) professional practice is contested and worked out, (iii) these encounters can be considered as learning experiences that contribute to seafarers developing a tacit understanding of what constitutes 'good seamanlike practice', and (iv) norms of good practice emerge and are reinforced. Our argument is that collision avoidance between ships is a jointly produced interactional accomplishment in which seafarers acquire tacit knowledge of what constitutes good 'seamanlike' behaviour, *through* participation. We understand this practice as a form of community-based activity - as navigators coordinate their actions towards a common goal - and the associated social learning as a form of both individual and collective learning. Moreover, we argue that the form of learning as exemplified through the data is richer than cognition and the transmission of information, but involves 'whole person' learning, including affective and volitional elements.

Billett (2001), drawing on empirical work on workplace learning, argues different workplace contexts afford different opportunities for learning. What our analysis demonstrates is that navigators through their talk are working-out what constitutes 'good seamanlike practice'. In so doing, they are making visible what is normally hidden. The analysis has shown that, in practice, collision avoidance is a collaborative activity that involves looking ahead, anticipating the actions of others, and charting a safe course through a series of encounters. Moreover, they are doing so in a manner that acknowledges the perspective and concerns of others. This is reflected in the COLREGS in the need to 'act in accordance with good seamanship'. However, the data presented highlights the inherent vagueness at the heart of the rules that require navigators to learn to read a context and apply experience-based tacit knowledge. The learning of what constitutes good practice is acquired *through* practice, i.e. successfully working through interactions, and crucially it is about more than acquiring technical knowledge; rather it is about learning to see the situation and respond as a 'good' practitioner would – including recognising the situation from the perspective of the other. We further argue that, in making use of the radio to work through these real-life, time critical, high-risk navigational encounters, the behaviour can be viewed as a form of community-based learning.

In presenting our example as a form of community-based learning our data adds to recent work arguing that relevant communities may be diverse, involve weak ties and be virtual, rather than engaged in direct face-to-face interaction (Amin and Roberts 2008, Nicolini et al 2022). As in Owen's (2022) account of air traffic controllers and pilots distributed work to safely manage aircraft landings and take-offs⁷, we have argued that ship navigators while physically separated collaboratively work to solve a common practical problem and thereby gain experience that constitutes a form of learning. Hence, we see this as a form of mediated co-presence amongst individuals working toward a mutually inscribing common goal, in real-time, in a way that involves the sharing of information but also involves affective and volitional engagement.

Within this community of practice there is no clear hierarchy of expertise, i.e. no overt indicator of who is more expert. This problematises the idea of a trajectory of participation

within a community of practice – all are participating equally. This, in turn, raises the question of what it is an individual takes away from the interaction. Each response may be individual with no means of determining which is ‘correct’. As Beckett (1996) notes, Geraldine Gilliss has argued that:

[T]here is a danger in the reflection-in-action approach of creating wholly idiosyncratic practitioners whose primary way of operating is to invent unique solutions to problems that [to them at least] are unique. Uniqueness, carried to extremes, is a barrier to the development and sharing of knowledge.”

In our case, we argue that what constrains the interpretation of the action is the overall aim of collision avoidance as orientated to the COLREGS, which serve as the focus and common framework around which decision-making is structured. As Schön (1983) (cited by Beckett 1996: 40) notes:

Through countless acts of attention and inattention, naming, sense-making, boundary-setting, and control, they [that is, communities of practitioners] make and maintain the worlds matched to their professional knowledge and know-how.

Consequently, while different individuals may claim competence at different points in time and in different situations, actions are visible to the community and may be challenged/contested and need to, in principle, be accountable. The point is interactions are visible to nearby vessels and shore-based monitoring stations and, importantly, ship Captains may ‘see’ what their officers are doing. For those officers choosing to use the radio, these interactional encounters, including challenge and justification, are made explicit allowing the processes that inform the development of norms of good practice to be made visible.

To conclude, we have presented a novel dataset that adds to the corpus of workplace studies and sheds light on a key activity central to a global industry. And, significantly, provides access to an otherwise hidden world, demonstrating the significance of tacit knowledge and learning *through* doing. For researchers into Vocational Education and Training this demonstrates the benefits of responding to technological changes and using original methods to examine real time practice. More substantively, through our analysis, we have shown how individual learning is enhanced *through interaction* with remote others beyond organisational boundaries in ways that involve sharing information but also affective and volitional engagement. In so doing, this paper contributes to extending the CoP concept by demonstrating the significance of group learning in terms of the emergence of norms of good practice and the need to see learning as more than the transfer of information. The significant point is that group learning constitutes a distinctive type of learning that is not reducible to individual learning, a point that has limited acknowledgement within the vocational education and training literature.

Furthermore, our aim has been to introduce the concept of community learning to those concerned with education in the maritime sector. We have demonstrated that the accomplishment of safe navigation is a social activity that needs to be more clearly reflected

in the design and assessment of the maritime curriculum. This would mean a pivot away from the current focus on assessment of the individual to greater focus on collaboration and group learning (see, for example, suggestions by Boud and Bearman (2022)). Simulator training plays an important role in maritime training and, while recent work recognises the importance of learning through reflection on practice, it remains focused on the individual (Sellberg et al 2021). We suggest that greater use of simulator training and focus on group activities and interactions more generally (including mixing individuals with different levels of experience) may enhance current training.

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¹Lloyd's Register Foundation is an independent global charity engineering a safer world. It supports research, innovation, and public outreach to reduce risk and enhance the safety of the critical infrastructure that modern society relies upon.

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¹ We note the gendered nature of this term, here we repeat the language used in the regulations; seafaring is a highly gendered profession with women constituting just 1.28% of the 1.89 million workforce.

² All ships listen out and make initial contact on channel 16, but to avoid blocking this channel they then select one of the established alternative channels to conduct their discussion.

³ For full detail see Author A (2008)

⁴ The rules allow for communicating uncertainty by sounding 'five short blasts' on the ship's whistle.

⁵ It has helpfully been pointed out, by one of the anonymous reviewers, that the argument could reasonably be developed as illustrating expertise as a 'capacity for action' – as outlined in Guile and Unwin (2022). We view this as an interesting direction to pursue but one that is beyond the focus of this paper.

⁶ These interactions are taking place in open water not narrow channels, where different rules apply.

⁷ We would like to thank one of the anonymous reviewers for bringing this article to our attention.

We would like to acknowledge that in the development of the concept of CoP, one turn taken has been to move the emphasis from the community onto the practice and so refer instead to Practices of a Community (Gheradi 2009) we are sympathetic to this suggestion but again feel it is beyond the scope of this paper to address it here.