

An Exploration of the Theoretical Foundations of Onboard Seafarer Training: A Systematic Review of the Literature

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ABSTRACT: At the core of the shipping enterprise is the competence of the crew of the ships. For this reason, the international community (particularly as represented by the International Maritime Organization (IMO)) has always endeavoured to ensure that seafarer education and training is as optimal as can be achieved by the global community of nations. A variety of elements are normally associated with such education and training. They include educational elements conducted ashore in maritime education and training institutions (classroom-based lectures, laboratory exercises and simulators, for example) as well as training conducted on board a ship in service. It has been well recognised that one of the most effective means of practical training for seafarers is the training conducted on board ships, so-called "onboard training". There is, however, a wide range of approaches taken by different jurisdictions in their application of specific strategies for onboard training. The approaches may differ in timing (at what stage of the educational process onboard training is conducted) and duration (how long the training is carried out), for example. These differences exist even though onboard training itself may be argued to universally derive its primary philosophical basis from the learning theories of situated learning and cognitive apprenticeship. To identify the rationale and factors informing different approaches to the implementation of onboard training from a theoretical perspective (establish a theoretical framework), and thereby to set the stage for the interrogation of how these approaches will address the challenges of the future (arising, for example, from the acceleration of technologically-mediated education and training), it is necessary to, first of all, examine how apprenticeship and on-the-job training have been perceived in the theoretical literature inside or outside the maritime domain and how the different approaches are informed by these theories. This paper, therefore, employed a systematic literature review to identify the theoretical foundation of on-the-job training and apprenticeship.

Objective: To explore theoretical foundations of apprenticeship/on-the-job training and how they may apply to onboard training in the maritime industry.

Methods: The authors conducted an electronic literature search with specified selection criteria for inclusion/exclusion using two databases - EBSCO Discovery Service and SCOPUS. Thereafter, and through qualitative coding of the literature found, several research themes were identified and explored. Using an electronic search with a specific search strategy from the two databases, a total of 3476 studies were identified. After screening per the relevant inclusion and exclusion criteria, 48 studies were ultimately included in the review.

Results: The review of the 48 studies (from a wide range of industries) found no study that focused on the theoretical foundations of onboard training specifically. However, it was confirmed from the study that three macro learning theories – relating to situated learning, cognitive apprenticeship and the zone of proximal development - are the dominant theories that relate to apprenticeship and on-the-job training in general. This review also found that different perspectives relating to processes of learning, guidance and support and the materiality of the context are critical considerations for apprenticeship and on-the-job training. Future research should explore how these factors are manifested in or considered by seafarer education and training jurisdictions when they select specific onboard training strategies and how other forms of competence building (such as training on simulators ashore) may or may not be limited in augmenting or replacing time onboard ship.

Contribution: This work addresses a gap in the literature relating to the theoretical underpinnings of onboard training in the maritime industry and contributes both a theoretical/conceptual framework for onboard training and a theory-informed definition of this expression of apprenticeship. Knowledge about these theoretical underpinnings is essential as the industry considers options for the remission of sea time, the increased automation of ships and the diversity of practices of onboard training in different jurisdictions.

1 INTRODUCTION

Today, approximately 80% of global trade by volume is carried by ships [1]. Competent seafarers have always been, and still are, at the core of the shipping industry. The achievement of the appropriate levels of competency to operate ships safely, efficiently, and in an environmentally-friendly manner has, in turn, relied heavily on Maritime Education and Training (MET) systems, whether national or global. The term “Maritime Education and Training (MET)” is used in this article in the narrow sense of the education and training of seafarers leading to the achievement of the relevant and necessary competencies for the safe and efficient operation of ships. Furthermore, the term “MET system” of a jurisdiction, in the context of this paper, encompasses the legal norms, administrative processes and procedures, and the actual conduct of the delivery and assessment of seafarer education and training in MET institutions in that jurisdiction as well as the oversight of any associated onboard training, leading to internationally recognized certificates.

Starting from moving boats using oars, to operating sailing ships, to the use of external (steam turbine) and internal combustion engines and finally to operating contemporary highly sophisticated ship propulsion and navigational equipment, hands-on experience and on-the-job training (OJT) have played a significant role in the development of seafarer competence. The components of MET are both education for theoretical knowledge and training for the acquisition of practical skills. It is acknowledged that practical training at sea is one of the most effective training interventions necessary for seafarers to obtain the relevant ship-operating skills [2]. In practically all cases, apprenticeship and on-the-job training are andragogical concepts. The two, while pervasive across industry sectors (in particular in vocational or quasi-vocational settings), differ in their expression in specific industry settings. In the maritime industry, a rich history/tradition of onboard training has found expression in international law. Per the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) promulgated under the auspices of the International Maritime Organization (IMO), there are specified periods for such “onboard training” for different ranks on board ship, e.g., for obtaining a certificate of competency for officers in charge of a navigational watch on ships of 500 gross tonnage or more [3]. The Convention was agreed upon in 1978, with major amendments made in 1995 and 2010. It prescribes minimum standards of training, certification and watchkeeping for seafarers [4] and today underpins the global governance regime for ensuring seafarer competence. As of 01 June 2023, the Convention has been ratified by 167 countries representing 98.91% of the global merchant fleet [5].

For example, in the Convention and its accompanying Seafarers’ Training, Certification and Watchkeeping (STCW) Code, the minimum required duration of onboard training as a part of mandatory seagoing service for candidates for officers in charge of a navigational watch (covered by Regulation II/1 and Section A-II/1) is prescribed as 12 months. However, MET systems in different jurisdictions have provided onboard training opportunities in different

formats, as evidenced by the practices of their Maritime Education and Training Institutions (METIs) used here to mean institutions that educate and train seafarers. Most students of METIs develop theoretical knowledge and practical skills in a shore-based context, with opportunities for practical training on board ships during and/or after the initial theoretical education. Despite some similarities in this approach across different jurisdictions, there are also significant differences among different MET systems in the specific implementation strategies for onboard training, such as regarding timing (at what stage of the educational process onboard training is conducted) and duration (how long the training is carried out). For instance, in the California State University Maritime Academy in the United States of America, students need to go on board the institution’s training ship - “Golden Bear” - for two months during their first school year, three months during the third school year and two months during the fourth year [6]. In the Maritime Institute Willem Barentsz NHL Steden University of Applied Science in the Netherlands, students go for onboard training for five months during their third year of study and the same during the fourth year, in both cases on commercial vessels not owned/controlled by the institution [7]. As the two examples illustrate, there is also a difference in whether students are trained on training ships belonging to the METIs or on commercial vessels. These differences in implementing onboard training appear to be underpinned by different factors. The existence of different historical, cultural and institutional factors, or even national legislation perspectives, means that each institution often employs different approaches to designing and implementing onboard training arrangements.

Onboard training has been argued to be the best opportunity for students to learn and acquire the necessary knowledge and skills in the context of their professional environment under the supervision of their senior officers [8]. The degree of practice and participation of students and support by senior officers are gradually varied to incrementally develop the appropriate levels of knowledge and competence of students. This process of skills development is characteristic of most apprenticeship models, with learning in the workplace being deemed as on-the-job training. It can be assumed that the different approaches of different MET systems to the implementation of onboard training are informed/influenced by implicit or explicit theoretical understandings and assumptions. However, no study has attempted to understand the different arrangements for onboard training and, importantly, the rationale, factors and learning theories that underpin their use. To identify the rationale and factors informing these different implementation approaches from a theoretical perspective, there needs to be, initially, an examination of how apprenticeship and on-the-job training have been perceived in the literature inside and outside the maritime domain. This paper, therefore, employed a systematic literature review to identify the theoretical foundations of onboard training based on general apprenticeship and on-the-job training models with the aim of informing future empirical work interrogating the practice of different

States/jurisdictions with respect to onboard training. Knowledge about such theoretical underpinnings is also of value in the discourse on whether onboard training should be replaced by or augmented with other forms of training, such as training on simulators ashore [9], [10], an issue currently being considered by the International Maritime Organization [11].

2 METHODOLOGY

2.1 Systematic Review

Due to the diversity of terminology and an increased need for evidence-based research derived from literature, a wide range of literature reviews have been developed over time. Grant & Booth [12] identified what, in their view, are the 14 most common types of reviews and tried to make the distinctions between them clearer and more substantive. One of the most prominent is the systematic review which has been extensively used, particularly in the healthcare field [13]. A systematic review is employed to answer a research question by collecting evidence as reported in the literature, which has been selected with specific eligibility criteria [14]. Through the systematic review, the researcher can identify, compare and contrast available studies in a relevant field and provide a comprehensive overview of the state of any particular research discourse. In 1996, in recognition of the suboptimal reporting of meta-analyses, an international group developed guidelines and a statement on the “Quality of Reporting of Meta-analysis (QUOROM). Subsequently, in 2009, these guidelines were revised, becoming the “Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) [13]. In 2020, further refining of the guidelines/checklist was completed [15]. This paper follows the guidance provided by PRISMA 2020 in a bid to ensure the authenticity and reliability of the findings. The findings from the literature review are then interrogated in the context of contemporary ship operation and per the current requirements of the STCW Convention, 1978, as amended.

2.2 Eligibility criteria used for literature selection

The study focused on literature addressing the theoretical foundations of on-the-job training and apprenticeship-based training. The scope of literature was limited to peer-reviewed journals and conference papers available in English and accessible from academic databases. This limitation in scope was due to the relatively higher authenticity and reliability of the peer-review process as compared to the processes underpinning the publication of other literature. Two electronic databases, SCOPUS and EBSCO Discovery Service, were searched to identify eligible studies. These two databases were chosen because of 1) institutional accessibility and 2) their performance in comparison to other databases [16]. According to Carrera-Riveira et al. [17], Scopus was, in 2022, the largest existing multidisciplinary database. Together with EBSCO Discovery Service, there was confidence that a full integration of major and globally diverse publication sources would be accessed.

The search terms used are indicated in Table 1.

Table 1. The categories of keywords used for searching strategy

Category	Number	Keywords
Apprenticeship	#1	apprenticeship
	#2	apprentice
	#3	on-the-job
	#4	intern
	#5	work placement
	#6	cadetship
	#7	#1 OR #2 OR #3 OR #4 OR #5 OR #6
Theory	#8	theoretical
	#9	theory
	#10	foundation
	#11	principle
	#12	basic
	#13	#8 OR #9 OR #10 OR #11 OR #12
Training	#14	training
	#15	train
	#16	#14 OR #15
	#16	maritime
Maritime	#17	marine
	#18	seafarer
	#19	cadet
	#20	onboard
	#21	shipboard
	#22	#16 OR #17 OR #18 OR #19 OR #20 OR #21
	Integration	#23

The searching strategy employed for this study was: #7 (apprenticeship OR “on-the-job” OR apprentice OR intern OR “work placement” OR cadetship) AND #13 (theory OR theoretical OR foundation OR principle OR basis) AND #16 (training OR train) OR #22 (maritime OR marine OR seafarer OR cadet OR onboard OR shipboard).

The exclusion and inclusion criteria are shown in Table 2.

Table 2. Exclusion and inclusion criteria

Exclusion criteria:
- Not written in English
- Not including a theoretical discussion
- Not research on apprenticeship or on-the-job training
- Unrelated to education and training
Inclusion criteria
- Written in English
- Full text accessible
- Peer-reviewed journal and conference proceedings

A total of 3,476 studies were identified through the first search on 25 November 2022 using the search strategy described. 370 studies were excluded by removing duplicates. Further, 2,277 studies were excluded as they were not peer-reviewed articles or written in English, thus not meeting the inclusion criteria. After initial screening focusing on titles and abstracts of the remaining 829 studies, 702 studies were further excluded mainly because the scope of the studies either did not include theoretical discussions or the research informing the studies was not on apprenticeship or on-the-job training. The final evaluation of the remaining 127 studies for inclusion in this review was conducted through careful reading of the full text of the studies. Further to this and as recommended by Gomersall et al. [18], the decision to include/exclude any of the 127 papers was taken based on the agreement of two researchers through discussions. As a result, 82 studies were excluded because 1) they were unrelated to education and training or 2) they did not include theoretical perspectives. Three more studies were included by searching another database comprising of peer-reviewed proceedings of conferences of the International Association of Maritime Universities (IAMU). This database was searched due to the fact

that the proceedings are a compilation of maritime-related studies representing the work of the most dominant global association of METIs with observer status at the IMO.

Ultimately, a total of 48 studies were included in the review.

Figure 1 shows the flow of the identification of studies via databases.

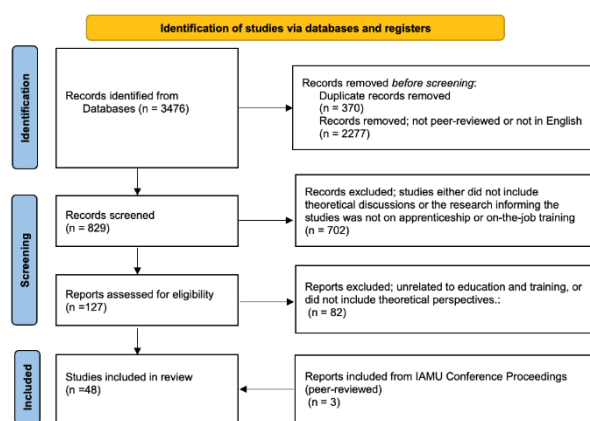


Figure 1. The flow of identification of studies from the databases

3 RESULTS, QUALITATIVE ANALYSIS AND SYNTHESIS

Details of the included literature are appended to this paper as Appendix A. After a thorough re-reading of the full text of all included studies, the text was thematically interrogated by applying qualitative codes to key sections using the qualitative data analysis and research software, ATLAS.ti version 22. In this in vivo coding approach, the coding work was first started by generating general terminological codes from paragraphs of the studies, followed by more specific codes applied in the second and third cycles of the coding process. Through these processes, codes were applied to references to learning theories and to several other key terms. The identified theories and terminologies (codes) were then categorised into several themes. The thematic areas generated include:

1. Industrial context
2. Definitional perspectives of apprenticeship and on-the-job training
3. Learning theories and process of learning
4. Guidance and support during the apprenticeship/on-the-job training

The following sections give a description of each identified theme.

3.1 Industrial context: Thematic description

One of the contexts where apprentice-based training has been well recognised and employed as an effective means of education and training is in the healthcare industry [19]. This review identified sixteen studies in the healthcare industry. Four studies are about surgeon training [20]–[23] and four

about medical interns [24]–[27], with the remaining related to education and training for emergency medicine [28], medicine [29], [30], family medicine [31], psychiatric rehabilitation providers [32], physician [33], medical specialists [34] and nursing [35]. Beyond the healthcare context, a wide variety of industries also apply or take into consideration the element of apprenticeship or on-the-job training for competence-building. These include firm and retail [36], [37], teaching professionals [38]–[41], hotels, restaurants and leisure [42]–[44], military [45], [46], the automobile industry [47], information science [48] and the steel industry [49]. All studies in the maritime context are related to education and training for seafarers [8], [50]–[54]. Notably, however, no study was found addressing the theoretical foundations of apprenticeship/on-the-job training of seafarers in particular.

3.2 Definitional perspectives of apprenticeship and on-the-job training: Thematic description

Even though the searching strategy included the term “apprenticeship” and “on-the-job training”, not all studies provided precise definitions of these terms. The term “apprenticeship” itself appears to have different connotations in different contexts. From the employment perspective, in an organisational setting, it can be viewed as a period or specific contract for a new employee. In contrast, from the perspective of the learning process, the term can be viewed as addressing a context within which a novice develops competence. The literature identified several perspectives on apprenticeship and on-the-job training. Ertelt et al. [55] describe apprenticeship as “the basis for the occupational career, which is defined by the chosen vocation” (p. 2), while Ryan & Unwin (as cited in [49]) refer to apprenticeship as:

“A structured programme of vocational preparation, sponsored by an employer, juxtaposing part-time education with on-the-job training and work experience, leading to a recognised vocational qualification at craft or higher level, and taking at least two years to complete, after requisite general education” (p. 409).

In general, the studies reviewed appear to emphasise the employment dimension of apprenticeship more than the learning processes and theories that underpin the concept. However, in a more general contribution by Matsuo [36], he indicates that apprenticeship is “a key method for passing down professional crafts and skills from one generation to the next” (p. 229). This description seems to have some relevance to the view of apprenticeship as a process underpinned by specific learning theories. Similarly, Phoyen & Boonroungrut [56], in an examination of different views of apprenticeship, define apprenticeship as “a process by which learners learn from a more experienced person by way of cognitive and metacognitive skills and processes (e.g., assisting, providing support and examples)” (p. 2570). In other literature, the aspect of socialisation in the apprenticeship process is also discussed. Kelly [22] highlights that apprenticeship comprises a vital form of social induction into a particular professional practice together with an

acquaintance with and development of relevant technical expertise. Similarly, Guile and Young [57] note that “apprenticeship has been viewed as a process of socialisation into official or unofficial workplace cultures and not explicitly as an approach to learning” (p. 5). Unlike the differences in emphasis on the different aspects of apprenticeship as described in the preceding, the literature exhibits some consensus in respect of the search term “on-the-job training”. Jacobs & Jones (as cited in [36]) describe on-the-job training as “a form of training that occurs at the workplace during the performance of a job, usually involving one-on-one instruction” (p. 225). Bas [58] notes that on-the-job training “takes place at an ordinary workplace and makes the task itself a part of the instruction given and a means for the acquisition of practical skill” (p. 1). Collins, Brown & Newman (as cited in [54]) describe on-the-job training as being the best part of the training in developing the competencies to act successfully on the job. The consensus position of the literature leads to a clear definition of “on-the-job training”: training conducted in the context of the workplace and in direct relation to the conduct of the specific tasks a trainee needs to be competent in.

3.3 *Learning theories and process of learning: Thematic description*

With respect to the theme of learning theories, 16 out of the 48 studies reviewed refer to “situated learning theory”. Similarly, 16 studies also refer to “cognitive apprenticeship”, five of which include references to both “situated learning” and “cognitive apprenticeship”. Three studies furthermore refer to “situated learning”, “cognitive apprenticeship”, and “zone of proximal development”. Some studies refer to “experiential learning” and “social learning”, in some cases used with other theories. As this study aimed to identify the theoretical foundations of onboard training as it relates to learning, this theme was particularly relevant in the interrogation of the literature. The most significant learning theory emerging from the review (in terms of frequency of mention) is “situated learning theory”, which was originally proposed by Lave and Wenger [59]. Situated learning theory is a theory that sees learning as taking place through a process of increasingly legitimate participation in a community of practice, from the periphery of that community to its core. The term “community of practice” sees significant mention in much of the literature reviewed, either together with situated learning theory or alone. Khine & Hartman [34], examining the influences of disadvantaged backgrounds on learning and professional development, suggest that learning can only occur if students participate in and contribute to the relevant community of practice while recognising the importance of the role of mentors in understanding the level of learning of students from the perspective of the zone of proximal development. Another study by Cope et al. [21] recognises the effectiveness and importance of the situated learning approach for constructing professional identity in surgical training. They point out that the trend in increasing duty hours potentially leads to insufficient contact between trainer and trainee, which may result

in critical shortcomings for the surgical trainee in the construction of their professional identity. Another study [20] echoes this view, noting that fewer opportunities for students to access a community may lead to a non-effective situated nature of learning. In Kelly’s view, this warrants the development of a new apprenticeship model. Tsui & Chen [42], in their study of the application of the cognitive apprenticeship teaching approach to food and beverage service training and the evaluation of learning satisfaction, also highlight the importance of interaction between students and teachers in a situated learning environment. Ridzwan & Yasin [60] examine issues in modern apprenticeship systems and identifies five stages of the process of formation of skills. They highlight that modern apprenticeship systems emphasise cooperation between trainees and instructors to develop a community of practice. Guile and Young [57] examine workplace learning from situated learning theory and zone of proximal development points of view to seek a new perspective on apprenticeship based on social learning theory. One study on different Swedish apprenticeship training programmes (post-secondary apprenticeship (PSA) and upper secondary apprenticeship education (USAE)) identifies the core assumption that the occurrence of workplace learning is derived from a community of practice [61]. A study on an apprenticeship in an African car repair company reports the learning process of apprenticeship by highlighting the material aspect in the situated nature of learning [47]. Li et al. [62] study how the concept of communities of practice is used in the business and healthcare sectors through a systematic literature review. They note that structures of community of practice within the two sectors significantly varied, ranging from informal networks to formal education and from apprenticeship training to project teams. In the maritime context, two studies refer to situated learning theory. Emad [8] suggests that the lack of visible trace of work processes of digitalised equipment onboard may restrict learning by observation for seafarers and examines how enhanced communities of practice are effective in maritime education. He proposes an alternative framework, a “quasi-community”, that is applicable to teaching and learning in a formal setting. Similarly, in another study, he examines how to create a community of practice in classroom-based education in the maritime context [52].

Cognitive apprenticeship, as proposed by Collins and Brown [63], is also well recognised in the studies reviewed. It is an instructional model inspired by traditional apprenticeship in the school environment. Several of the studies are related to the application of the cognitive apprenticeship model in educational settings. Cognitive apprenticeship differs from a traditional apprenticeship; Lacy [39], for instance, clearly differentiates traditional apprenticeship and cognitive apprenticeship. She suggests that traditional apprenticeship has limitations on what it can teach as it is set in the workplace and focuses on teaching skills, while cognitive apprenticeship “differs in that the tasks and problems are chosen to illustrate the effect and power of certain techniques and methods” (p. 267), and it “emphasises generalising knowledge so that it can be used in many different settings and articulating the common principles so that students

learn how to apply their skills in varied contexts" (p. 267). There are several studies which attempt to apply the cognitive apprenticeship model in different contexts. For instance, Merrit et al. [28] explore a new method of faculty development in emergency medicine through the lens of the cognitive apprenticeship model. The study by Tsui & Chen [42] is also, as mentioned earlier, in principle about the application of the cognitive apprenticeship teaching approach to food and beverage service training and the evaluation of learning satisfaction. There are also similar studies on the applicability of the cognitive apprenticeship model to competency-based teaching development [38], teaching professionals [40], family medicine [31] and Psychiatric Rehabilitation Provider Training [32]. Although a study by Stalmeijer et al. [26] reveals that the cognitive apprenticeship model teaching is applicable to clinical education, they point out that insufficient time for teaching or a lack of skills for teaching impacts the effectiveness of such education. Similarly, Khine & Hartman [34] highlight the importance of guidance and support for the learner to ensure the practical application of cognitive apprenticeship. In the maritime domain, two studies refer to cognitive apprenticeship. Emad & Oxford [53] point out issues in the contemporary practice of maritime education and training and propose applying the cognitive apprenticeship model to this formal learning setting. Reul [50] explains how cadet training in shipping (onboard training) and simulator training is perceived as cognitive apprenticeship models of training in the maritime domain.

A related construct (to cognitive apprenticeship) is Vygotsky's "Zone of Proximal Development" [64]. Vygotsky, in discussing learning and development in children, defined the Zone of Proximal Development (ZPD) as: "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers." (p. 86)

Not surprisingly, the concept (of ZPD) is also well recognised in the studies reviewed. Kelly [22] refers to the zone of proximal development in highlighting the importance of determining the trainee's level of understanding and changing an individual's particular profile in the surgical training setting. In the study of clinical education, Tran et al. [27] suggest that early support by supervisors "would help to flatten the shape of the early learning curve", thus preventing trainees' burnout and attrition. Khine & Hartman [34], however, in a critique of the concept, indicate that it does not emphasise the personal differences between mentor/trainer and mentee/trainee as such differences (e.g., cultural and racial differences) may affect the potential development of the trainee. Guile & Young [57] study the contemporary concern of vocational education and training and identify "three different conceptions of the "zone of proximal development" – the "normative", the "social" and the "transformational"" (p. 187) and propose reconceptualising apprenticeship as a social learning theory. One study examining the timing and manner in which support should be provided for medical trainees suggests that scaffolding and support are essential for trainees in

the early stage of the training as trainees have more questions and need more advice from the zone of proximal development point of view [27]. Emad & Oxford [53], citing Vygotsky, note that coaching assists students in going beyond what they could accomplish by themselves.

There are six studies that refer to "experiential learning". Kolb [65] defines experiential learning as "the process whereby knowledge is created through the transformation of experience" (p. 38). A study by Phoyen & Boonroungrut [56] proposes a systematic and integrated model of apprenticeship, the so-called "Enterprise Innovation-driven Apprenticeship Programme", which draws from experiential learning as a theoretical base of the apprenticeship. The study highlights experiential learning as one of the critical learning theories relevant to the design of an appropriate learning management system. Matsuo [36], in his study on the instructional skills for on-the-job training, refers to experiential learning and highlights that excellent on-the-job trainers facilitate learners' experiential learning by defined and reflective practice. Experiential learning is also regarded as one of the adult learning theories in the study of effective surgical education [23]. Ridzwan & Yasin [60] highlight that experiential learning is the key to individual skill development in the field of vocational training. Kelly [22] also suggests that more emphasis should be placed on experiential learning for designing a supportive learning environment for surgical training.

Although the number of studies in the maritime domain is limited, situated learning theory, cognitive apprenticeship, and zone of proximal development are confirmed as the dominant theories in the apprenticeship model training and on-the-job training.

3.4 *Significance of guidance and support during apprenticeship/on-the-job training: Thematic description*

In the apprenticeship system, a novice learns craft skills under the supervision of experts through practice. There are several studies which highlight the significance of the role of educators, supervisors and, in some situations, even peers (more knowledgeable others). Kelly [22], in her suggestions for designing an appropriate learning environment for surgeons, suggests developing a collaborative curriculum, recognising the interchangeable roles of teacher and learner. Another suggestion is to involve the wider community and other clinicians in the teaching, learning and assessments. Khine & Hartman [34], in a study of medical speciality training, identify the influence of the degree of guidance of consultants for medical speciality trainees on the latter's success in qualification. The study describes how a group of trainees who had sufficient support from their consultants and formed relationships with peers in different institutions qualified for the programme. In contrast, another group of trainees who failed to receive constant guidance from their supervisors due to communication and socio-cultural barriers left the programme without the requisite qualifications. In the study, the qualified group of trainees indicated that

self-directed learning was one of the factors for their success; however, they indicated that they still needed guidance from consultants. The study further identified that institutional support for consultants is vital for providing appropriate support to their trainees.

One study on General Practice Registrars in Australia observed that learners need more advice in the early stage of their learning. It notes that "supervisor-led scaffolding and support is required earlier in registrar training in order to facilitate the potential of individual trainees to navigate and learn from the transitional experience, rather than be overwhelmed by it" [27, p. 10]. Similarly, in the application of cognitive apprenticeship teaching, Tsui & Chen [42] highlight the importance of the assistance of the master to learners during the learning process. Cope et al. [21] also highlight the importance of the traditional apprenticeship model of providing a close working relationship between the master and apprentices and suggest that the role of the teacher is to enhance the motivation of students to learn and also to "continue to provide external motivators to encourage sustained behaviour change" (p. 548). Ohta et al. [31] also highlight the importance of regular reflection and supportive teacher-student relationships; consequently, the learner becomes self-directed with the encouragement of teachers. Hamoen et al. [29], in their study on online clinical workplace learning, also highlight that a lack of continuous relations between students and teachers leads to less-than-optimal clinical training. Li et al. [62] conclude from the conduct of a systematic literature review that several studies highlight the importance of facilitators; however, the review is unable to identify the actual responsibility of facilitators. Ertelt et al. [55] point out the importance of professional guidance, particularly during career transition, and also emphasise the strength of workplace learning as it provides opportunities for novices to test their technical skills under the guidance of practitioners. The study further states that the role of mentors is essential in the provision of appropriate guidance and support during apprenticeship practice for promoting skills, social competence and the pleasure of learning. The significance of close cooperation and interaction is also highlighted in the studies. Ridzwan & Yasin [60] point out that modern apprenticeship emphasises cooperation between learners and educators and sets up a community of practice. Jaarsma et al. [47] describe the role of the senior participants as being to "primarily serve as intermediates, helping the apprentice to find his or her way in the community of practice by direct guidance or, more indirectly, through being observed by them" (p. 441). The study on instructional skills in Japanese firms confirms that interaction between newcomers and supervisors plays a crucial function in newcomers' socialisation and adaptation. J. van Zolingen (as cited in [36]) highlights the role of the mentor in serving "as a behavioural model, to provide feedback, arrange an adequate environment for self-study, motivate trainees for self-study and evaluate trainees' progress on a regular basis" (p. 229) and assumed that trainers who have excellent instructional skills are deemed to be good trainers. The study by Matsuo [36] concludes that "excellent on-the-job trainers facilitate trainees' experiential learning by stretching trainees' objectives,

monitoring their progress, providing positive feedback and promoting reflection of results more frequently than non-excellent trainers" (p. 238). The study further highlights that the approach improves learners' motivation and self-efficacy. Pylväs et al. [66] similarly highlight that social support and positive feedback are significant elements for learners' study and work success. According to Merritt et al. [28], different levels of guidance are required for varying levels of learners in the application of the cognitive apprenticeship model in Emergency Medicine education. Similarly, the importance of regular reflection is highlighted;

"The teachers engaged them in discussions about patient management, during which the students reflected on their feelings and challenges. This process helped them understand how the teachers perceived their roles and how to fulfill their demands. The teachers modified their teaching styles and ways of interacting with the participants based on the reflections." [31, p. 37]

According to Fjellström & Kristmansson [61], in the Swedish education system, the roles of supervisors differ depending on educational level. The supervisor in a USEA (upper secondary apprenticeship education) is in charge of communicating learning issues and finding an appropriate task related to the course syllabi, while in a PSA (post-secondary apprenticeship) context, an experienced colleague is a supervisor who guides the learner to full participation in the community. In acknowledging the fact that workplace goals and apprenticeships' personal goals are differently initiated, the authors highlight that guidance from experienced colleagues is crucial. On the contrary, one study identifies that cooperation, support and assessment from peers are more important than the role of supervisor [33].

In the maritime context, Emad & Oxford [53] point out that the lack of supervision and unwillingness of the crew and shipping company to get directly involved in training is one of the challenges for cadets when they undergo onboard training. They raise the issue that limited opportunities for the cadet to participate in activities onboard may lead to failure in reaching the required levels of competence. In the same vein, Evidente & Estimo [54] concluded that the quality of experiences from onboard training depends on the officers who are assigned to training the cadets. The two studies illustrate how the quality of training depends on the crew on board, noting, however, that the crew on board have their own responsibility in the busy schedule of a ship [53] and they may not be trained to do so.

Although proper guidance and assistance are critical for skill development, several studies indicate that self-directed learning could be a supplement for development. For instance, Khine & Hartman [34] suggests that self-directed learning can be an alternative way to reach a certain level of knowledge and skill when appropriate guidance is unavailable. Similarly, Matsuo & Nakahara [67] highlight that direct supervision has the potential to enhance individual learning, although it may limit novices from generating and sharing ideas in the workplace.

It is noteworthy that apart from references to the STCW Convention in the maritime literature, none of the studies reviewed identify or discuss the role of legal standards (national or international) on the nature of apprenticeship and/or on-the-job training. This can be argued to be a very important concept when apprenticeship on board ship is interrogated and therefore is included in the next section of this paper which discusses the findings.

4 DISCUSSION

The purpose of this study was to examine the theoretical foundations and principles of apprenticeship and on-the-job training. The systematic literature review identified 48 studies drawn from a wide variety of industries which examine the theoretical elements of apprenticeship and on-the-job training. Neither the few maritime studies nor any other studies focus particularly on the theoretical foundations of onboard training specifically. In general, the literature addressed three apprenticeship-related “dimensions” – the employment dimension, the learning dimension, and the socialisation dimension. Further to these, a number of concepts/issues are present in the wider literature that could - taken together holistically – help in the articulation of a comprehensive theoretical framework underpinning onboard training on ships.

4.1 *Relevant concepts arising from the review and their applicability to the onboard training*

Among the significant concepts/issues to be considered in the maritime context are the applicability of the following to onboard training:

1. Career development and employment
2. Cognitive apprenticeship theory
3. Experiential learning theory
4. Situated learning theory
5. The Zone of Proximal Development
6. Social learning theory
7. Materiality in social and situated learning
8. Mentoring and guidance structures
9. Self-directed learning
10. Legal standards and requirements (national and/or international)

In this section of the paper, a discussion is undertaken of these concepts/issues, their relation to onboard training on ships and their contribution to/implications for a theoretical framework aimed at interrogating such training as a manifestation of apprenticeship/on-the-job training.

4.1.1 *The career development and employment element of onboard training*

In ship operation – a complex and highly competence-driven context – onboard experience (and the explicit or implicit training inherent) is expressed as “seagoing service” and forms an essential part of professional development, ranking and operational responsibilities.

For officers holding Certificates of Competency as defined in the STCW Convention, progression with respect to levels of responsibilities (from operational to management level) is predicated on the completion of a seagoing service which is tantamount to on-the-job training. The first step of gaining the first operational level CoC is patently an apprenticeship period for the development of the requisite competencies. Indeed, the Convention defines “seagoing service” as “service on board a ship relevant to the issue or revalidation of a certificate or other qualification”, thus linking such service (apprenticeship/on-the-job training) to the qualifications that ensure career progression. As such this concept is critical as a constituent element of any theoretical framework underpinning onboard training on ships.

4.1.2 *The applicability of the cognitive apprenticeship*

As highlighted in the preceding section, this review identified a number of studies which attempt to apply the cognitive apprenticeship model of learning in different contexts [30], [38], [44], in particular in the healthcare field [26], [28], [32], [35]. From the identified studies and their conclusions, the effectiveness of the model should not be underestimated. These studies, however, also highlighted that the unavailability of experts in skills development might affect the effectiveness of this model of instruction [32], and experts may have difficulties in providing sufficient guidance if there is a large number of learners [35], [40]. As Reul [50] clearly described, cadetship (onboard training) is a context where the cognitive apprenticeship model has been applied. If all components of the sequence of learning are successfully incorporated into the workplace, either on training ships or commercial ships, this model is particularly effective for the learning and development of the competence of cadets. However, operational factors such as the fast turnaround of ports, the small size of the crew, the unwillingness of the crew to teach their cadets and insufficient knowledge of officers about pedagogy and learning [53], as well as differences in level or type of experiences among cadets [50] may also affect the learning experience and outcome for the cadets.

4.1.3 *The applicability of experiential learning theory*

Several of the studies reviewed refer to “experiential learning”. The study on the instructional skills of on-the-job trainers highlights that excellent on-the-job trainers facilitate learners’ experiential learning by defined and reflective practice [36]. Kolb [65] defines experiential learning as “the process whereby knowledge is created through the transformation of experience” (p.38). As highlighted by Ridzwan & Yasin [60], experiential learning is the key to individual skill development in the field of vocational training. Engagement in the practical elements of maritime education and training in general, and onboard training in particular, are regarded as the most effective means for skill development for seafarers [2]. The training on board a ship is where students are first exposed to the real work environment. Any kind of experience on board can be a concrete experience for students to get used

to being in the life onboard. For successful knowledge creation in the experiential learning theory, four elements: concrete experience, reflective observation, abstract conceptualization, and active experimentation are necessary [65]. However, as suggested by Evidente & Estimo [54] in the first instance, the quality of cadets' experience is highly dependent on the ship's senior officers. If cadets do not have sufficient supervision from senior officers, they may encounter difficulties in conducting reflective observations for example. Although the learning cycle may be achieved by individual cadets alone, less experienced cadets still need guidance and support from senior officers both in regard to the primary concrete experience and active experimentation to gain optimum competency outcomes. With proper supervision and appropriate guidance, cadets create knowledge through experiential learning cycle and thereby build competence from their practical experiences.

4.1.4 *The applicability of the situated learning theory*

Situated learning theory, as proposed by Lave and Wenger, was also widely referred to in the identified studies. The critical components of this theory are the notion of a community of practice and the process of progressive participation in such a community from the periphery to the central community while constructing identity [59]. Cope et al. [21] identify that identity construction depends on social aspects, including the training environment. They observed that learners in the medical field start as assistants, and then through participating, they take more central roles. However, they also pointed out that operational characteristics of the work environment, such as increased duty hours, could lead to insufficient contact between trainers and trainees and fewer opportunities to access a community, which may result in the non-effective situated nature of learning. This view was also supported by Kelly [20]. On ships, the situated learning experiences and the communities they are exposed to may differ based on whether the onboard training is in the context of a purpose-built training ship or on commercial ships. On the former, cadets may create their own (cadets') community engaging with training officers in the school mindset. This environment can be argued to be very different from that on commercial ships where the cadet, while not explicitly a crew member by law, may nevertheless have duties and responsibilities in cooperation with a professional seafarer community whose primary focus is not the training of the cadet. The cadets participate in the "real" community where experienced and professional seafarers work. The cadets' "migration" from the periphery of this professional community to the centre, as they gain the necessary skills and competencies, increasingly constructing their identities as seafarers and ultimately as they reach the competence level to be certified officers, is clearly indicative of the movement described by Lave and Wenger. In both training ship and commercial ship contexts, this movement is present. However, the communities into which the cadet is assimilated differ with advantages and disadvantages apparent in both.

4.1.5 *The applicability of the social learning*

Albert Bandura's novel learning theory, social learning, albeit not much referred to in the studies, is also found to be a key theory in apprenticeship and on-the-job training [47]. Social learning theory hypothesises that learning occurs through observation and modelling. However, it is only possible when there is attention, retention, reproduction, and motivation [68]. Matsuo & Nakhara [67], for instance, explicitly highlighted this aspect as follows: "OJT [on-the-job training] includes providing employees with spontaneous explanations or demonstrations related to their job responsibilities and enabling them to subsequently hone their skills by trial-and-error learning or by observing and imitating the behaviors of others" (p. 198). This explains the learning process of social learning in the workplace learning explicitly. Shipboard training provides opportunities for cadets to observe their senior officers' practice and then to have opportunities to model that practice. It is, however, essential to note that per this theory, learners need to be motivated to learn [21]. It is also suggested that improper guidance may discourage learners from learning [40]. The theory suggests that in the onboard training of seafarers, it is important to understand the interrelation between activities by learners (observing, modelling, trial) and the motivation of the learners in the context of onboard training.

4.1.6 *The applicability of the Zone of Proximal Development and the "More Knowledgeable Other" (MKO)*

While Vygotsky applied his concept of the Zone of Proximal Development to children, it is obvious that the concept as such has applications to adult learning in general (see, for example, [22], [57]) as well as to apprenticeship and on-the-job training in particular. In the context of this paper and with respect to onboard training, the word "adult" in his definition can be replaced by "supervisor", "trainer" or a similar term such as "More Knowledgeable Other" (MKO) as used by Abtahi [69], [70]. The modelling behaviour of the "expert"/MKO in the ZPD theory is obviously akin to the social influence of the community of practice when moving from the periphery to the core in situated learning theory. Indeed, Vygotsky's ZPD is derived from a socio-cultural understanding of learning emphasising the importance of social interaction [64]. In addition, proper support and scaffolding are necessary, especially for students in their early stages of learning [27]. The theory is also applicable to the interrogation of cadets' experiences in the early stage of their training period when they may not be familiar with the ship environment. Without proper guidance and an appropriate level of support, the safety of cadets may even threaten what is often a hazardous operational context. Support and guidance are critical components for learning from the perspective of the zone of proximal development, and per the theory, that support/guidance should take cognizance of the trainee's level of understanding at any particular time and link the appropriate level of tasks given to cadets to that level of understanding.

4.1.7 *The notion of materiality in social and situated learning*

The study by Jaarsma [47] highlighted the importance of materiality in social learning. They shed light on how the material nature of a car repair company had a substantial impact on informal apprenticeship training. Although this aspect was not explicitly found in other studies in this review, it is apparent that the learning environment significantly impacts the apprenticeship and on-the-job. Some, albeit not explicitly, have identified the importance of the learning environment, including training facilities [71] and an authentic environment [26], [56]. Emad [52] pointed out that the physical layout of the classroom impacts learning. During onboard training context, cadets are exposed to the real and holistic environment (the authentic environment), including navigation instruments, cargo handling equipment, life-saving appliances, etc., all in active operation. These "materials" include the physical equipment (hardware and software) for operating the ship. The influence of materiality on human cognition (artefacts, objects) has long been recognised (see for example, [72], [73] and [74]). Material things have a significant influence on learning and behaviour. In the case of seafarers, who live and work in the full presence of their working materials, situated learning appears to be imperative for gaining of the requisite operational competencies at a sufficiently in-depth level of knowledge. In the operational shipping context, learning is not only associated with the existence and operation of the material artefacts/objects/things/equipment in the work environment but also the responsibility for their operation and maintenance. It is often the case that officers have specific responsibility for one or more of these materials. Through their social learning experience and with particular reference to materiality, cadets learn both the operation/maintenance of these materials and the taking of the responsibility associated with such operation/maintenance. It is noteworthy that such responsibility is often associated with outcomes that relate to life-death situations. Materiality in authentic environments should therefore be a critical consideration in theorizing about shipboard training.

4.1.8 *The place of mentoring and guidance structures*

As was highlighted in the preceding sections, appropriate guidance and support for the learners are critical components in the context of apprenticeship and on-the-job training. Not surprisingly, there are a number of studies which showed the importance of guidance and support for apprenticeship and on-the-job training, which was highlighted in the preceding sections. In this review, learning theories, situated learning, cognitive apprenticeship and zone of proximal development are well referred to. Trainers, supervisors, or more knowledgeable others are necessary components of these learning theories, albeit the level and nature of guidance structures differ. As highlighted by Jaarsma [47], the role of senior participants is to help the apprentices find their way in the community of practice by modelling actions and behaviours. There are also studies that highlight the role of the supervisor in motivating

students and taking into account their level of knowledge [26], teachers' ability [23], social support and positive feedback [40], and professional guidance [55] for successful learning. It was, however, also pointed out that the lack of sustained relationship between students and teachers [29], lack of constructive feedback [22], the limited access of the trainees to "trainers" due to service (operational) pressure [20], communication barriers between supervisors and learners and insufficient time for coaching and mentoring due to overworked staff [34], could all lead to improper learning opportunities for learners. The onboard training environment is argued to be the best place for students to holistically learn all technical skills and the relevant disciplines on a ship in a real-life authentic environment. However, the environment and operational conditions may not always be ideal for learning. Although this may differ between training on ships designated as training ships and that on commercial ships, there are usually experienced (senior) seafarers or dedicated training instructors who are supposed to give guidance from the very beginning through the entire period of their training (e.g., 12 months in the case of deck officers for the first certificate of competence). The role of those senior officers is to be mentors, supervisors, teachers, and more knowledgeable others to give guidance, support, and help cadets joining the community. Optimal onboard training, from a theoretical perspective, will therefore have to incorporate structured and sufficient guidance and support from those senior officers with opportunities for learners to observe modelled behaviour and build close relationships with their seniors without communication barriers. However, as highlighted by several researchers [50], [53], [54], cadets' learning is threatened by improper or inadequate supervision or guidance by senior officers, a situation exacerbated by significant operational demands in the maritime industry and smaller crew sizes, similar to the situation observed in the medical/surgical training context pointed out by Cope et al. [21].

4.1.9 *The place of self-directed learning*

The literature discussion on the significance of guidance and support during the apprenticeship/on-the-job training also highlights self-directed learning as being a supplemental or alternative way to learn in case there is no or limited guidance or support [34]. Per the cognitive apprenticeship model (discussed earlier in section 4.1.2), many factors affect the learning process, including insufficient feedback, lack of time available, and the unwillingness of crew to train in particular in the maritime context. However, as mentioned in the introduction of this paper, seafarer education and training under the STCW Convention are essentially andragogical in nature. While not explicitly mentioned in any of the papers reviewed, an interrogation of Knowles' assumptions underpinning adult learning shows a clear relationship with many of the concepts and theories discussed in the literature.

1. Adult learners, from a natural process of maturation, move from dependency in a learning situation toward increasing self-directedness. This is clearly linked to the migration from the

periphery to the core of a community of practice as described in Vygotsky's ZPD.

2. In the process of maturation, learners accumulate a "reservoir" of experience which they bring to subsequent learning experiences and attach more value to learning gained from experience. One can see links between this and Kolb's experiential learning theory.
3. Adult learners approach learning from a need-to-learn basis e.g., linked to career development and the need to develop skills for the carrying out of practical professional tasks. This tendency is often related to the career development and employment element of apprenticeship. The output/performance element is key to any competency-based professional setting as ship operation is.
4. Following on from #3, adult learners are accordingly internally motivated. This motivation sustains the self-directedness presented in Knowles' first assumption.

It is therefore clear that both self-directedness and internal motivation on the part of trainees/apprentices are key considerations for theorising about onboard training. This is necessary, as pointed out by some of the (maritime) literature in this review, to inform an interrogation into the degree to which apprentices in the maritime context (cadets) are motivated and self-directed - in particular in the circumstances where learning opportunities are limited due to the unwillingness of crew to teach, the small size of crew, a short turnaround of ports, and other operational constraints. Also necessary is the examination of the extent to which such self-directed learning can be safely resorted to, for example, when it comes to the operation of critical equipment. Irrespective of any such limits to self-directed learning, it remains - with appropriate guidance and support - important for competency development in apprenticeship in general [34], [48] and in onboard training in particular.

4.2 *Legal standards and requirements (national and/or international)*

It is worth noting from the review that in many jurisdictions, the apprenticeship process is deemed to be a substantive part of a career development process and may be part of an explicit formal educational system. While the studies do not specifically mention this, it is normal jurisdictional practice that educational systems are underpinned by law most often at the national level. This is clearly the case with the maritime industry where the primary expression of apprenticeship (onboard training of cadets) is explicitly indicated in the text of international law (primarily the STCW Convention) and implemented at a national level through national law via ratification of the international instrument [3]. What appears to be missing in the implementation of this legal requirement, is the consideration of the concepts unearthed in this review in the design and delivery of onboard training mechanisms and strategies. Per the STCW Convention, all sea service must be "approved" meaning "approved by the Party (i.e., ratifying State) in accordance with the regulations of the Convention". Approvals in this context relate to the exercise of authority in these matters by a State

party to the convention. Ideally, State practice in granting such "approvals" should be premised on the application of the relevant theoretical framework such as may result from the review in this paper in order to ensure that onboard training is optimum and serves the purpose and spirit of the legal requirements of the Convention.

4.3 *Interaction between the different domains of learning and macro learning theories*

Surprisingly, none of the papers reviewed explicitly discussed the domains of learning (cognitive, psychomotor and affective) in their applicability to apprenticeship, nor do they explicitly address the main macro learning theories of cognitivism, constructivism, behaviourism or connectivism. It can be argued, however, that the learning domains are an important consideration when developing a theoretical framework through which onboard training may be examined. Regarding the macro learning theories, arguably, the cognitive apprenticeship theory falls under the broader notion of cognitivism as does the learning styles approach advocated by Kolb. Similarly, elements of Vygotsky's theories, self-directed learning, as well as experiential learning, situated learning and social learning may be aligned with constructivism and connectivism. The motivational and psychological aspects of apprenticeship learning and onboard practices of drills and repeated practices may be argued to have leanings toward behaviourism. The stimuli-response process of behaviourism is otherwise not very obvious in a theoretical discussion of onboard training.

4.4 *A theoretical definition of onboard training*

The STCW Convention, 1978, as amended, describes "onboard training" as used in its regulations II/1, III/1 and III/6, as covering approved seagoing service as part of an approved training programme. Despite the existence of this description in international law, there is no theoretical definition of the concept that will support its theoretical and academic analysis and its practical implementation. Considering, therefore, all the elements that have emerged from this work, the notion of onboard training on ships can be defined holistically and from a theoretical point of view as "an expression of career-related apprenticeship in the maritime industry (ship operation) where an individual/learner/novice is immersed in a learning process situated in the operational reality of a community of practice (CoP) exhibiting a high degree of materiality and where the individual's learning, while being self-driven/self-directed, is framed by the influence of "more knowledgeable others", mentoring structures and institutional support that together facilitate the movement of the novice from the periphery of the CoP to its core through the acquisition and continuous development of relevant positive knowledge, skills and attitudes".

It is noteworthy that, while this definition may or may not be warranted by law (whether at the national or international law), the legal status of the apprenticeship, in and of itself, is not germane to the definition of the construct.

Figure 2 is a conceptualisation of a theoretical framework arising from this definition and the discussions in this paper.

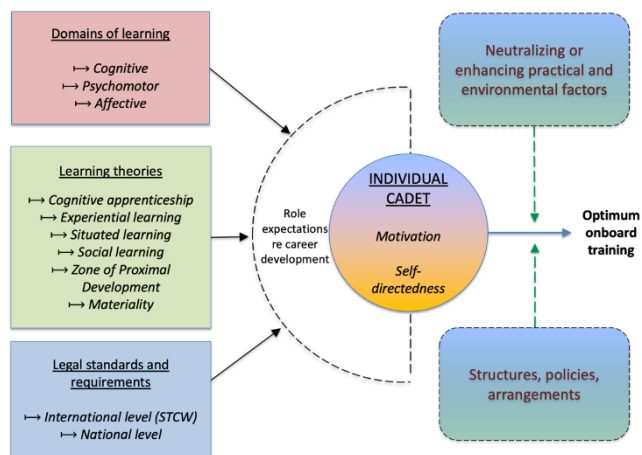


Figure 2. Conceptualisation of a theoretical framework

In light of this definition and framework, future interrogation of the administration, design and practice of onboard training, whether at the national, institutional or shipboard levels, as well as the interrogation of any changes to onboard training arrangements arising from the introduction of technology on ships (for example in relation to different levels of automation), should consider how the elements inherent in the definition are addressed. Such considerations should also exist in educational settings ashore when examining the merits of shore-based interventions to augment onboard training (e.g., with simulation).

The above discussion is premised on human presence onboard ships for operational purposes.

5 IMPLICATIONS

It is evident from the elucidation of a theoretical foundation for and definition of onboard training that the practice of States in respect of their implementation of the international law regulating onboard training (STCW regulation II/1, III/1 and III/6, for example), as anecdotally reported, is not always aligned to optimum best-practice. The theoretical issues raised in this paper are not always exhaustively applied in the design and implementation of onboard training programmes. Future research should seek to 1) examine the accuracy of this assertion, 2) explore the degree to which the practice of States aligns with the framework, and 3) explore methods, models and procedures that can improve the application of practices that are well-informed theoretically on a global scale. Furthermore, the clear trend in global education towards the “atomisation/individualisation” of learning – with the increased internet-mediated focus on self/independent learning should be challenged (in particular when it comes to apprenticeship) in light of situated and social learning theories. For example, where simulators are considered as a replacement and/or augmentation of actual sea experience onboard ship, the theoretical issues raised in this paper – ZPD,

social learning, mentoring, materiality etc. – should be very well addressed.

6 LIMITATIONS

This review is based on a search of the indicated electric databases. The possibility of missing valuable studies from other sources, such as the book chapters and studies which are not available in the electric format, cannot be obviated. Furthermore, the searching strategy applied to this review is limited to the “theoretical” perspective of apprenticeship and on-the-job training; it cannot be denied that there may be possibilities of identifying studies related to the practical rationale for the apprenticeship or on-the-job training. In the screening, some studies were excluded because they were not studies from a theoretical perspective. However, the elements that go into optimum onboard training will include practical and jurisdictional issues that may go beyond the theoretical areas explored in this work. It may be desirable to undertake research in the future, which includes studies that inquire into these factors.

7 CONCLUSION AND FUTURE WORK

Onboard training is one of the most effective means of training for seafarers. It is, among other things, critical for METIs to ensure the quality of onboard training provided for their students. This systematic literature review aimed to identify the theoretical foundation of apprenticeship and on-the-job training. Through the review, while we found 48 studies from a wide range of industries, there was no study which focused on the theoretical foundations of onboard training. However, it is confirmed that three learning theories, situated learning, cognitive apprenticeship, and the zone of proximal development, are deemed to be dominant theories for apprenticeship and on-the-job training. This review also found that different perspectives on apprenticeship and on-the-job training and the process of learning and guidance and support are critical components of apprenticeship and on-the-job training. Through discussing the elements, such as the applicability of the learning theories and essential factors to achieve successful learning, a theory-informed definition of onboard training was determined. Acknowledging the effectiveness of the application of these theories for education and training in different industries, future research should explore how these factors are manifested or considered by seafarer education and training jurisdictions when they select specific onboard training strategies.

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APPENDIX – LIST OF REVIEWED STUDIES

No	Author	Year	Title	Publication	Industry	Research aim
1	Bas	1989	On-the-Job Training in Africa.	International Labour Review	Wickerwork, carpentry and jewellery	
2	Bates et al.	2012	The Cognitive Apprenticeship Model: Implications for its use in Psychiatric Rehabilitation Provider Training.	Journal of Rehabilitation	Health care	Application of Cognitive Apprenticeship to Psychiatric Rehabilitation Provider training
3	Chan et al.	2009	Cognitive Apprenticeship as an Instructional Strategy for Solving Corporate Training Challenges.	TechTrends: Linking Research & Practice to Improve Learning	Business	Application of Cognitive Apprenticeship for corporate training
4	Cope et al.	2017	What Attitudes and Values Are Incorporated into Self as Part of Professional Identity Construction When Becoming a Surgeon?	Academic Medicine	Health care	Study on different perspectives on apprenticeship at their advantage and limitation
5	Duemmler and Caprani	2017	Identity Strategies in Light of a Low-Prestige Occupation: The Case of Retail Apprentices	Journal of Education and Work	Business	The analysis of identity construction strategies in retail apprentices
6	Emad	2010	Introduction of technology into workplace and the need for change in pedagogy	Procedia - Social and Behavioral Sciences	Maritime	Study on the seafarers' acquisition of discipline-based knowledge at maritime institution
7	Emad	2010	Tracing legitimate learning in formal vocational education	Procedia - Social and Behavioral Sciences	Maritime	The analysis of competency development process of mariners in the vocational education and training system
8	Emad and Oxford	2008	Rethinking Maritime Education and Training	Proceeding of the IMLA	Maritime	The investigation on the current issues in maritime education and training system
9	Emad	2021	Reforming Professional Education: A Case of Cognitive Human Factor/Human Element in Shipping Industry	Advances in Human Factors in Training, Education, and Learning Sciences	Maritime	The examination of the conventional and emerging workplace learning opportunities in the maritime context
10	Ertelt et al.	2021	Apprenticeships as a Unique Shaping Field for the Development of an Individual Future-Oriented "Vocationality".	Sustainability	Vocational Education Training general and in	The analysis of curriculum to identify learning outcomes in apprenticeship
11	Evidente and Estimo	2014	Lived Experiences of Maritime Cadets: Their First Encounter Onboard Multicrewing Vessels	Proceeding of the IAMU	Maritime	The study on the realities of the onboard training from the point of view of cadets
12	Fjellström and Kristmansson	2019	Constituting an apprenticeship curriculum	Journal of Curriculum Studies	Vocational Education Training general and in	The analysis of curriculum to identify learning outcomes in apprenticeship
13	Fuller and Unwin	2013	Learning as apprentices in the contemporary UK workplace: creating and managing expansive and restrictive participation	Journal of Education and Work	Steel industry	The analysis of the valuable learning opportunities in different approaches under the modern apprenticeship
14	Ghofranipour et al.	2018	Improving interns' patient-physician communication skills: Application of self-efficacy theory, a pilot study.	Cogent Psychology	Health care	The evaluation of the effect of self-efficacy theory on the interns' communication skills development
15	Glogoff and Flynn	1987	Developing a systematic in-house training program for integrated library systems	College and Research Libraries	Information Science	The investigation of possibilities of computer-assisted training in surgery
16	Gorman et al.	2000	Computer-assisted training and learning in surgery	Computer Aided Surgery	Health care	Examination of effective teacher education for special educational needs
17	Greer et al.	2016	Helping Doctoral Students Teach: Transitioning to Early Career Academia through Cognitive Apprenticeship	Higher Education Research and Development	Teaching professional	The application of cognitive apprenticeship for teaching development for doctoral candidates
18	Guile and Young	1998	Apprenticeship as a conceptual basis for a social theory of learning	Journal of Vocational Education and Training	Vocational Education Training general and in	The discussion on the reconceptualization of apprenticeship in vocational education and training
19	Hamoen et al.	2022	Design and First Impressions of a Small Private Online Course in Clinical Workplace Learning: Questionnaire and Interview Study	JMIR Medical Education	Health care	The evaluation of the effect of small private online course in the clinical internship in internal medicine
20	Høifødt et al.	2007	A qualitative study of the learning processes in young physicians treating suicidal patients: From insecurity to personal pattern knowledge and self-confidence	BMC Medical Education	Health care	The analysis of the learning experience of newly educated physicians' learning process
21	Jaarsma et al.	2011	The Role of Materiality in Apprenticeships: The Case of the Suame Magazine, Kumasi, Ghana	Journal of Vocational Education and Training	Automobiles	Study on the role of materiality in informal apprenticeship training
22	Kelly	2006	Too busy to think, too tired to learn' - the attrition of the apprenticeship model of surgical training in the United Kingdom	Educate~	Health care	Evaluating the current hospital-based clerkship training, and proposing the new models of training
23	Khine and Hartman	2021	Significance of relationships in the cognitive apprenticeship of medical specialty training.	African Journal of Health Professions Education	Health care	Evaluating the influences of disadvantaged backgrounds on the learning and professional development
24	Lacy	2012	Learning Transactional Analysis Through Cognitive Apprenticeship	Transactional Analysis Journal	Teaching professional	The analysis of the relationship of cvognitive apprenticeship and transactional analysis in teaching, training and supervision
25	Li et al.	2009	Use of communities of practice in business and health care sectors: A systematic review	Implementation Science	Business health care and	The systematic literature review of use of community of practice in business and health care

						sector	
26	Liu	2005	Web-Based Cognitive Apprenticeship Model for Improving Pre-Service Teachers' Performances and Attitudes towards Instructional Planning: Design and Field Experiment	Educational Technology & Society	Technology	Teaching professional	The application of the web-based cognitive apprenticeship for pre-service teachers
27	Massé et al.	2020	Transformative medical education: Must community-based traineeship experiences be part of the curriculum? A qualitative study	International Journal for Equity in Health		Health care	The examination of learning gained from traineeship experience within the community-based clinical context
28	Matsuo and Nakahara	2013	The effects of the PDCA cycle and OJT on workplace learning	International Journal of Human Resource Management		Fire and insurance	The examination of the effect of the PDCA cycle and on-the-job training in the workplace
29	Matsuo	2014	Instructional Skills for On-the-Job Training and Experiential Learning: An Empirical Study of Japanese Firms	International Journal of Training and Development		Business	The study on the characteristics of the trainer's instruction skills for on-the-job training
30	Merritt et al.	2017	A Cognitive Apprenticeship-Based Faculty Development Intervention for Emergency Medicine Educators	Western Journal of Emergency Medicine		Health care	The application of cognitive apprenticeship for faculty development for emergency medicine
31	Motta et al.	2017	Co-regulations of learning in small groups of chef apprentices: when do they appear and what influences them?	Empirical Research in Vocational Education & Training		Hotels, Restaurants & Leisure	The analysis of development of co-regulation in the chef apprentices
32	Neuenschwander et al.	2018	Professional desires and career decisions: Effects of professional interests, role models, and internship in lower secondary school	International Journal for Research in Vocational Education and Training		Vocational Education and Training in general	The examination of influence of professional interest, direct experience and indirect experience for career decision
33	Ohta et al.	2021	Strengths and challenges for medical students and residents in rural Japan	Family Medicine		Health care	The evaluation of changing motivations and learning behaviors for medical students and residents in rural community hospitals
34	Patrick et al.	2012	Being in one's chosen job determines pre-training attitudes and training outcomes.	Journal of Occupational & Organizational Psychology		Military	The evaluation of the one's chosen job for mode of training motivation
35	Phoyen and Boonroungrut	2021	Enterprise Innovation-Driven Apprenticeship: A Suggested Programme.	Turkish Online Journal of Qualitative Inquiry		Vocational Education and Training in general	The analysis of theoretical basis of apprenticeship and proposal for systematic and integrated apprenticeship model
36	Pinelli et al.	2018	Identifying the presence of cognitive apprenticeship in the layered learning practice model	American Journal of Pharmaceutical Education		Health care	The examination of the presence of cognitive apprenticeship in the layered learning practice model in health context
37	Pylväs et al.	2022	Vocational Students' Perceptions of Self-Regulated Learning in Work-Based VET	Vocations and Learning		Social and healthcare, business and administration, and construction	The evaluation of vocation students' perception of self-regulated learning in work-base setting
38	Rashid	2017	Surgical education and adult learning: Integrating theory into practice	F1000Research		Health care	The evaluation of adult learning theory for surgical education
39	Reul	2015	Maritime Training Through the Use of Simulators	Proceeding of the IAMU		Maritime	Study on effective maritime basic training from the theoretical perspectives
40	Ridzwan et al	2015	From training institution to workplace: Towards a training model in the industrial training institutes	International Education Studies		Vocational Education and Training in general	The examination of factors for skill development in the work-based learning in learning institutions
41	Ridzwan and Yasin	2015	Cultivating Learning: A Grounded Theory of Skills Acquisition for Vocation in Modern Apprenticeships	Procedia - Social and Behavioral Sciences		Vocational Education and Training in general	The analysis of skills acquisition for vocational apprenticeship
42	Robinson	2017	Effective inclusive teacher education for special educational needs and disabilities: Some more thoughts on the way forward	Teaching and Teacher Education		Teaching professional	Examination of effective teacher education for special educational needs
43	Roth et al.	2014	The theory-practice gap: Epistemology, identity, and education	Education and Training		Electricians, Airline and maritime	Study on theory-practice gap in education and training
44	Schmidt and Mott	2012	Development of a Graduate Education Program for U.S. Army Interns and Careerists	New Directions for Adult and Continuing Education		Military	The study on the partnership between higher education institution and military
45	Stalmeijer et al.	2009	Cognitive Apprenticeship in Clinical Practice: Can It Stimulate Learning in the Opinion of Students?	Advances in Health Sciences Education		Health care	The investigation of students' experiences on the learning climate and fitness of cognitive apprenticeship model in the clinical training
46	Tran et al.	2022	Transitions in general practice training: quantifying epidemiological variation in trainees' experiences and clinical behaviours	BMC Medical Education		Health care	The examination of variation in clinical and learning content, and location, of consultation by stage of training
47	Tsui and Chen	2020	Sustainable development of hotel food and beverage service training: Learning satisfaction with the situated cognitive apprenticeship approach	Sustainability (Switzerland)		Hotels, Restaurants & Leisure	Exploration of impact of cognitive apprenticeship teaching approach in food and beverage service training
48	Wu et al.	2012	A context-aware mobile learning system for supporting cognitive apprenticeships in nursing skills training	Educational Technology & Society		Health care	The study on application of combination of cognitive apprenticeship strategy and context-aware mobile learning system for nursing skills training