ENCOURAGING ATTITUDE, BEHAVIOUR AND COGNITIVE CHANGE IN SHIPS' OFFICERS: AS SIMPLE AS ABC?

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ABSTRACT

The primary aim of teaching is to enable students to learn [1]. This is a truism whether we are talking about students studying for degrees or about engineers participating in engine resource management courses. Another less obvious point that educational researchers make is that students' learning happens as a result of what the student does rather than what the teacher does [2]. We might be surprised to learn therefore, that in simulated environments at least, simulator instructors often learn more than the students do [3]. On the full mission simulator courses run at Warsash Maritime Centre, a team of researchers and lecturers is working together to ensure three things: (a) that students learn and learn the types of attitudes, behaviours and cognitions that have deep significance for their effectiveness on board ship; (b) that the course lecturers concentrate more on what the students do and less on what they do by designing learning sessions that get the students engaged; and (c) that the students learn more than the lecturers do through observation of, reflection on, and critical analysis of, their own behaviour. Accordingly, this paper describes the philosophical underpinnings and the behavioural change process upon which the delivery of these novel courses depends, and without which it would not be possible to achieve the three objectives described above. In the course of this exposition, particular attention is paid to explaining the Antecedent-Behaviour-Consequence (ABC) mechanism of learning by which the adoption of the new behaviours is encouraged and transferred to the shipboard environment. Furthermore the author explains why development of technical competence in shiphandling or engine management, while still important, is no longer the primary learning objective of these courses and why the emphasis is on developing the skills of communication, team co-ordination, leadership, situational awareness, and critical thinking. The paper concludes with a discussion of the limitations of simulator based resource management courses to foster behaviour change beyond the usual 'honeymoon phase' of any training intervention and outlines a new process being trialled by Warsash's Maritime Research Centre to overcome some of these limitations.

1. INTRODUCTION

Learning is a difficult concept to define, let alone gauge. Yet, to facilitate, even to engineer student learning, is, one could argue, the primary role of teachers of ships' officers. Unfortunately, research in education suggests that the learning that students are doing is often ineffective [4]. Large numbers of students have no greater understanding of their subject come the end of their course than they did at the start of their course, and this is true whether the students are studying to become accountants [5] or veterinaries [6]. While the students are learning, their learning is far from ideal or what the lecturers had intended:

> *"..very large numbers of students appear to be learning an imitation of at least some of the disciplines they are studying, a counterfeit amalgam of terminology, algorithms, unrelated facts, 'right answers', and manipulative skills that enables them to survive the process of assessment"* [7]

Ramsden's [8] findings suggest that there are different levels of learning and that the majority of students are not attaining the level that lecturers judge to be of value. This author maintains that what is true for higher education students is also likely to be true for ships' officers enrolled on simulator-based courses. In many instances at maritime colleges, course participants are not assessed and thus the lecturers have no knowledge of what has, or has not, been learned. Attendance is all that is required to obtain a certificate, and attendance does not necessarily equate with learning.

2. THEORIES OF LEARNING

The expectation of lecturers, implicit in the quotation from Ramsden above, is that students should be able to do more than learn 'right answers' and unrelated facts. Certainly in simulator-based courses, we are often aiming for attitude and behaviour change as well as cognitive change. However, before one can begin to design courses and promote teaching practices that encourage students to do more than memorise, one has to understand the levels of learning and the process by which students progress from one level of learning to another.

There are many theories of learning and much psychological research has been devoted to understanding the development of human cognitive and social behaviour. Biggs [9] talks of two approaches to understanding student learning:

- Constructivism or cognitivism
- Phenomenography

2.1 Constructivism

Constructivist theory is based on the premise that all individuals process, modify, store and retrieve information, forming internal representations of knowledge known as schemas. Constructivism, an evolution of cognitive psychology, promotes the idea that it is what students *do* in terms of mental processing that is important for learning [10].

Piaget

One key figure in the constructivist school is Piaget. Piaget studied children's intellectual development and found it to be staged, with older children able to perform more complex and more abstract logical and reasoning problems than younger children. The implications of Piaget's stages are that the complexity of material has to be appropriate to one's level of intellectual development, and present day constructivists would argue that this is true for adult learners as well as children. Furthermore, intellectual development was noted by Piaget to be a process of discovery in which a child continues to experiment on the world to discover its laws [11]. An imperative for constructivist-driven teaching therefore, is for students to develop intellectually, to learn, they need to be active discoverers of knowledge and meaning and not passive recipients of instruction and materials.

Bloom's Learning Taxonomy

Another cognitive psychologist, Bloom [12], developed a taxonomy of learning that was designed to help curriculum developers to specify objectives and plan learning experiences [13]. Bloom and his colleagues [14] divided their taxonomy into three domains:

1. Cognitive: knowledge and intellectual skills
2. Affective: interest, attitudes, and values
3. Psycho-motor: manipulative and motor skill

The categories in the three domains are presented pictorially in Figure 1. As with Piaget, this conceptualisation of development is hierarchical in nature moving from the simple to the complex and the concrete to the abstract. Furthermore, it is additive in nature, suggesting that prior levels have to be achieved before higher levels can be mastered.

SOLO Taxonomy

The last constructivist approach to be considered is that of Biggs and Collis [15]. Biggs and Collis developed a framework for 'understanding understanding' [16] referred to as the SOLO taxonomy; SOLO being short for Structure of the Observed Learning Outcomes.

Biggs assumes that most teachers are not interested in theories of learning but in improving their teaching. Thus, the taxonomy is not concerned with what is happening within the student's head, rather what is evidenced in the outcomes of teaching. Biggs proposes five levels of learning outcomes (as opposed to learning stages) for which he provides examples, and these have been paraphrased below:

1. *Prestructural*: students' responses to a question miss the point
2. *Unistructural*: students' responses deal with terminology but little more
3. *Multistructural*: students' responses are characterised by 'knowledge-telling' [17]; an unstructured 'brain dump' of facts
4. *Relational*: students' responses are characterised by explanation and relating of concepts, one to another
5. *Extended abstract*: students' responses go beyond what was presented in material to arrive at new conceptualisations of problems, issues or knowledge.

Biggs argues that it is only when students reach levels 4 and 5 that we can be sure they are truly understanding, and thus have learnt more than what Ramsden [18] refers to as an 'imitation of their discipline'.

2.2 Implications of Constructivism for Teaching

The clear message from the constructivist school of learning is that passive students are not learning students. Accordingly it follows that the lecture, whereby students sit and listen to the transmissions of the lecturer, is unlikely to be an effective teaching practice, especially if it is the sole technique employed. If the accounts of constructivists are correct, and evidence would suggest they are, then what is needed is a more student centred teaching style wherein students engage in problem solving.

Another message from this school is that understanding is achieved as the penultimate step in a series of cognitive development steps. The implication is that students who have not progressed through the initial steps will not be achieving understanding of a subject or discipline if presented with, or expected to produce, materials at a higher level of abstraction.

2.3 Implications of Constructivist Theories of Learning for Simulator Based Training

The implications of constructivism for simulator –based training are twofold:

(i) course participants are unlikely to learn much more than a few unrelated facts if the course is dominated by lectures, or, if the simulator is used as no more than a demonstration tool; and

(ii) simulator based training has to be matched to level of development of the course participants.

Expecting students to engage in the kinds of problem-solving and theorising expected in many simulator-based courses (the *extended abstract* end of the development continuum), when they are only unable to grasp simple concepts (the *unistructural* level) – is likely to result in limited learning at best, and the 'wrong' learning at worst. Borodizicz and van Haperen [19] argue that simulation is a training methodology that should be used 'when people are ready for [it] (p 16). They support their assertion by referring to the work of Lagadec. Lagadec [20] found that students who undertake simulations involving crises too early in their development become anxious and defensive. Lagadec also found that 'undertaking [crisis simulations] too late might merely set in-house attitudes in concrete' (p 331), suggesting that there is a time window for learning using simulations.

2.4 Phenomenography

This term, conceived by Marton [21], describes a theory of learning that places at its centre the student experience. While in concert with the constructivist idea that it is what students *do* that promotes learning, it diverges from constructivism in its conceptualisation of reality. Advocates of the phenomenographic approach believe that the role of the teacher is to change the student perspective of a phenomenon rather than to arrive at an end through the transmission of facts. Furthermore, the belief is the reality of a phenomenon is not 'out there'. Rather reality is 'seen as the relation between the individual and the phenomenon' [22].

Vygotsky

An example of a phenomenographic account of learning is Vygotsky's social learning theory [23]. Vygotsky approached learning from the point of view that it is too complex to be defined by stages [24; 25]. Vygotsky believed that learning in an individual could not be divorced from the social context in which that learning took place. Moreover, he considered the quality of the interactions between teachers and students as vital to learners' development.

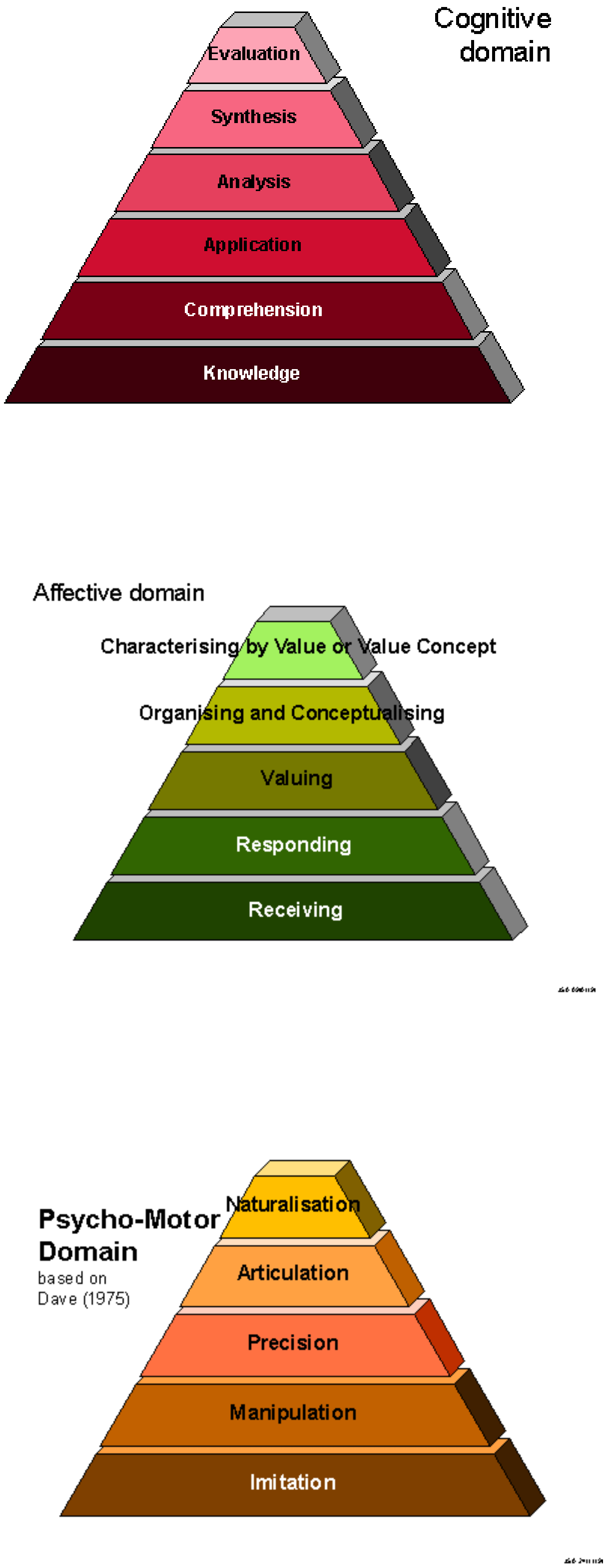

Figure 1. Pictorial Representation of Bloom's Learning Taxonomy

A central tenet of Vygotsky's theory is the concept of the *Zone of Proximal Development*. The zone of proximal development (ZPD) refers to the place a learner occupies when they are unable to solve problems without the assistance of others (e.g. peers, higher-ranking officers, teachers). The ZPD is the gap between where the learner is and where they could be; their potential level of development. As a learner transits through the ZPD one witnesses increasing levels of autonomy in their problem solving abilities.

There are some clues in Vygotsky's treatise as to the mechanism for achieving this autonomy, principally through social interaction. However, it was Bruner [26] that provided us with a mechanism for increasing learner independence: s*caffolding*. *Scaffolding,* a concept often attributed to Vygotsky, but actually conceived by Bruner, suggests that the way to encourage learners to develop autonomy is to gradually withdraw teacher control as the learner improves mastery.

Kolb

Another theoretical perspective highlighting the importance of the student experience, this time adult students' experience, is that of Kolb [27]. Atherton [28] goes as far as to suggest that Kolb's theory of experiential learning is 'one of the most useful descriptive models of the adult learning process available'.

According to Atherton, David Kolb's work has its origins in the Confucian saying:

> *"Tell me, and I will forget.*
>
> *Show me, and I may remember.*
>
> *Involve me, and I will understand."*

Kolb's model of adult learning is again a stage model (Figure 2), suggesting that adult learners progress through four stages starting with concrete experiences. The concrete experiences are reflected upon, and this reflection leads the learner to develop abstract concepts or theories. These abstract concepts are actively tested and this leads to the creation of new experiences. Kolb also maintains that learners have learning styles, preferences for operating in a particular stage of the learning cycle.

2.5 Implications of Phenomenography for Teaching

The main message that is contained in the phenomenographic accounts of learning is it is *how* a teacher teaches that has considerable implications for the effectiveness of learning. The phenomenographic school is in harmony with the constructivist school in maintaining that active students are learning students and that a teacher is likely to be ineffective if all they do is attempt to transmit information. The former school also presents ideas for ensuring that the process of teaching leads to engaged students. For example, Vygotsky's concept of the *zone of proximal development* and Bruner's concept of *scaffolding* would suggest that teachers should adopt a teacher-centred style to start with and move to a more student-centred style as students' mastery with a concept develops. Lastly, Kolb's theory of experiential learning suggests that for adult learners at least, there must be opportunity for reflection on experiences and active experimentation with new concepts for learning to take place.

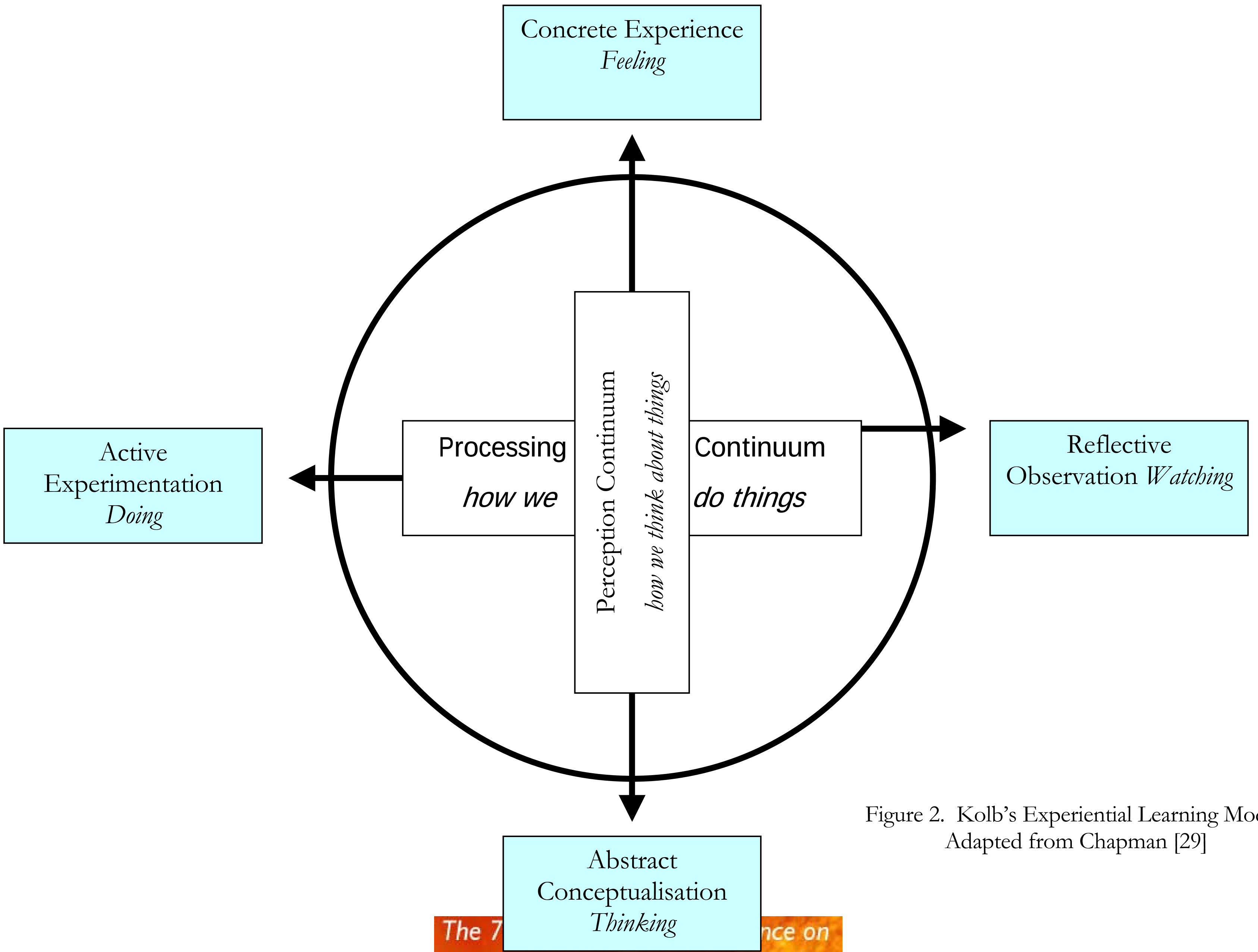

Figure 2. Kolb's Experiential Learning Model.
Adapted from Chapman [29]

2.6 Implications of Phenomenographic Theories of Learning for Simulator Based Training

According to phenomenographic theories of learning, learning is a process achieved through social interactions whereby those who have reached their development potential assist those in their *zone of proximal development,* and whereby individuals reflect on their experiences in the simulator. Therefore, the implications of phenomenography for training using simulators are as follows:

(i) students need to be weaned off reliance on the instructor through the gradual introduction of the simulator aspects of the course, as the course progresses

(ii) the opportunity for interaction between junior and senior officers needs to be encouraged as much learning occurs through dialogue with one's contemporaries

(iii) individuals who have achieved their development potential are potentially effective aides to the simulator instructor in teaching those still in the *zone of proximal development*; and

(iv) as adult learners, ships' officers need to be encouraged to reflect on their actions in the simulator exercises in order to process this information to develop new theories

Ultimately, therefore, simulator instructors and course designers need to pay as much attention to the design of the interactions in the classroom, staging of the delivery of classroom and simulator components, and debriefing post the simulation exercises as they do to the simulation exercise itself.

Interestingly, in the case of simulation exercises designed to facilitate the development of crisis management skills, Borodzizc and van Haperen [30] note that due to a lack of a normative theory for managing crises, simulator instructors and course designers often learn more from the exercises than the students do. As true as this may be, Borodzizc and van Haperen need not be surprised, for it has been found that 'to teach is to learn twice' [31].

2.7 Behaviourism

There is one final school whose theories of learning do not fit easily into the constructivist – phenomenographic distinction made above. The behaviourist school considers the relationship between stimulus, response and reinforcement important for learning. The main tenet of the behaviourist school is behaviour that is rewarded will be repeated and behaviour that is punished will cease [32]. Therefore, behaviourist theories have implications for understanding how the student-teacher interaction can influence learning. For example, the stimulus to a class might be a thought provoking question and the response might come from a student in their zone of proximal development who is trying out a new construction of understanding. A teacher whose response validates (rewards) the student's attempt is likely to give confidence to the student to try out their thinking again. A teacher whose response embarrasses (punishes) the student is likely to shut down the student's thinking.

2.8 Implications of Behaviourist Theories of Learning for Simulator Based Training

For adult learners, volunteering one's opinion or understanding in a group situation can be a high-stakes matter and thus can be very intimidating. A lecturer engaged in debriefing an exercise needs to be a skilled facilitator and needs to be aware of the impact their responses can have on student engagement. On the one hand, s/he needs to validate the student's attempt at reflection by positive reward. On the other hand, they have to be able to steer a student to the correct processing of the reflection to arrive at the appropriate new theory or learning.

3. DESIGNING A COURSE

Notwithstanding the need for staff skilled in the practice of lecturing and debriefing, the starting point in designing a course must be a consideration of what we are aiming for; what are the goals of our programme? Biggs [33] suggests that we should be designing for *constructive alignment*, or designing 'for teaching calculated to encourage deep engagement'. He suggests that we should start with the level or levels of understanding of the content that we want from our students. Knight [34] suggests in his USEM model that there are five things courses designers should be aiming to achieve:

Understanding of the subject matter;

Subject specific and generic skills (or social practices);

Efficacy beliefs and incremental self-theories that are the basis of a view that we can, by and large, make a difference to what we experience;

Metacognition, the reflection that supports it and strategic thinking in general

In reality, the course goals might be different according to whom one asks; students, employers, professional bodies, lecturers and government agencies are all stakeholders in the maritime education arena and each has different needs. It is incumbent on course designers and programme planners to be heedful of these stakeholder requirements, but not be swayed against their better judgement when it comes to coverage (see below).

3.1 Learning Outcomes

In making learning in maritime education transparent, and possibly in the process, facilitate the marketisation of education, curriculum planners need to make explicit what their courses are offering and how that can be evidenced. If goals or aims indicate the intentions of a course, then learning outcomes, as the name suggests, are the indicators that the intentions have been realised, i.e. the learner has learnt what was intended. A learning outcome can be defined as

> *"…a statement of what a learner is expected to know, understand and be able to do at the end of a period of learning and of how that learning is to be demonstrated. Learning outcomes are linked to the relevant level and since they should generally be assessable they should be written in terms of how the learning is represented" [35; p56]*

In guiding course developers in the writing of learning outcomes, Moon [36] suggests that the aim statement of a course should inform the direction and orientation in terms of content and the learning outcomes should inform the standard and learning challenge of the programme. Biggs [37] suggests that one takes as the starting point the SOLO taxonomy and decides the level of learning challenge by reference to the last stages of the model (one can discount the first stage) and recasts the stages in terms of verbs one expects the students to be able to do. For example, for a *Unistructural* learning outcome, one might expect the student to 'identify' or 'do a simple procedure'; for an *Extended abstract* learning outcome one might expect a student to be able to 'theorise, hypothesise, and reflect' [38; p48]. When it comes to depth and breadth of learning outcomes, or numbers of learning outcomes, on this point Gardner, an educationalist, is clear: 'the greatest enemy of understanding is coverage' [39; p24].

Understandably, purchasers of education and training for seafarers are asking questions about the value-added of the courses that their officers attend. They want to know that at the end of a course, an officer will have learnt what he or she needed to learn, and can apply the skills practised at the training institution, onboard ship. The purchasers' wish is to be assured that they have spent company money to best effect.

Lecturers, on the other hand, are acutely aware that to achieve attitude or behaviour change in days is an inordinately difficult task, especially when presented with a class of officers of differing rank, experience, and nationality. Unfortunately, the trap into which lecturers fall is to equate value for money with value added. Rather than adopting a teaching strategy that focuses on how students learn, they adopt a strategy that focuses on what the teacher teaches [40]. The result is that the expert lecturer transmits as much of his or her expertise as possible in the time given (value for money) rather than changing the attitude or behaviour of their class (value added) [41].

On this point, Moon suggests that a course should contain no more than eight learning outcomes arguing that if there are more than ten learning outcomes, they are likely to be too detailed and thus will make evaluation unmanageable.

4. SIMULATOR-BASED TRAINING

Historically maritime training has addressed the development of technical and procedural skills. Until recently, providing solutions to the problems of developing non-technical skills and the optimal use of crew resources has been neglected in maritime training.

Simulator-based training courses were introduced primarily to train the skills of passage planning and the importance of the Master/Pilot relationship [42]. This training initiative developed into the Bridge Team Management (BTM) courses that are conducted today on many simulators worldwide and, although not taught directly, they contain some of the elements to be found in Crew Resource Management (CRM) courses developed in other industries, such as aviation. These aviation courses were developed to focus on the non-technical skills of flight operations and include group dynamics, leadership, interpersonal communications, and decision making [43]. Bridge Resource Management (BRM) courses are a more recent initiative, adapted directly from the aviation model for training the non-technical skills of resource management, and are not always based on the use of simulators.

The 1980s saw the introduction of Engine Room simulators and, towards the end of that decade, cargo operations simulators also became available. However, it is only recently that the combined use of bridge and engine room simulators to provide a total ship simulation environment has been undertaken.

Resource management training has become established in the curricula of many maritime training establishments. Courses take a variety of forms and cover both deck and engine room disciplines. The courses are often simulator-based, but not always, and their syllabuses reflect CRM training in other industries. As can be seen from the history of this development, most major training initiatives have resulted from the lessons learnt from a succession of casualties.

A recent review of accident databases from the USA, UK, Canada and Australia confirms that human error continues to be the dominant factor in maritime accidents and reveals that in 70% of recorded incidents attributed to human error, failures in non-technical skills such as situation assessment and awareness predominate [44]. Indeed, the majority of accidents and incidents are *not* caused by technical problems but by the failure of the crew to respond appropriately to the situation. Arguably, most maritime professionals would agree with Helmreich *et al* [45] that in order to ensure safe and efficient operations there is a need to understand the behaviours of effective error detection and management. However, while other safety critical industries and the military have heeded this message and have been training and assessing resource management skills as a way of ensuring that errors are effectively detected and managed [46, 47, 48, 49], the maritime industry continues to lag behind.

The only mandatory requirements in the maritime domain for the development of the non-technical skills of resource management are those of the International Maritime Organization's (IMO) Seafarer's Training, Certification and Watchkeeping Code [50]. Table *A-V/2* of this code specifies the minimum standard of competence in crisis management and human behaviour skills for those senior officers who have responsibility for the safety of passengers in emergencies. The competence assessment criteria detailed within the Code are not based on specific overt behaviours, but rather on generalised statements of performance outputs, and as such are highly subjective and open to interpretation [51]. Although these standards of competence indicate that IMO recognises the need for non-technical management skills, both the standards and their assessment criteria are immature in comparison with the understanding of non-technical skills, and their assessment, within an industry such as civil aviation.

4.1 Crew Resource Management Training

At the Maritime Centre in Warsash, courses are now being developed that go beyond STCW 95. One such course, the Crew Resource Management (CRM) course, is almost entirely concerned with teaching human behavioural or non-technical aspects of ship operations. Technical aspects of ship operation, such as ship navigation or power generation, are not covered as separate items. Rather, the course curriculum is devoted to social and cognitive aspects of seafarers' performance, i.e. it is devoted to those skills thought to be important in assisting in the detection and management of errors.

A further novel approach of the Warsash course is the incorporation of human behaviour research findings in the training philosophy. The recognition primed decision-making theory [52, 53] suggests that there is a generic metacognitive skill that can be developed to be applied to handle any unpredictable situation. One aspect of this theory that is put into practice on the course is the enrichment of mental models through the building of repertoire patterns. Another aspect is the development of critical thinking skills through the practice of specific techniques in simulated scenarios [54].

4.2 The ABC of Learning

On the full mission simulator courses run at Warsash Maritime Centre, a team of researchers and lecturers is working together to ensure three things:

(a) that students learn and learn the types of attitudes, behaviours and cognitions that have deep significance for their effectiveness on board ship;

(b) that the course lecturers concentrate more on what the students do and less on what they do by designing learning sessions that get the students engaged; and

(c) that the students learn more than the lecturers do through observation of, reflection on, and critical analysis of, their own behaviour.

Taking as a starting point the aviation industry's model for CRM training as outlined in CAP 737 [55], the resource management courses at Warsash Maritime Centre aim to

- enhance the operational safety of the client company's vessels
- reduce the likelihood of an incident to a vessel
- reinforce the client company's vision and mission

The philosophy underpinning the management course is very much student centred as opposed to lecturer centred, and thus represents a course that seeks to add value to the participating officers through attitude, behaviour, and cognitive change. The instructional system or process employed at Warsash to bring about these changes draws on theories of learning identified in the foregoing. However, just allowing the students to 'behave' on the course with the lecturers providing no more than feedback (consequences) would be unlikely to beget the safety behaviours associated with effective error detection and management. The students need to be presented with new ways of thinking, new techniques, and new ways of behaving that will facilitate their abilities to handle problem situations.

In the language of behaviour based safety management, these new ways of thinking and behaving are the antecedents to safe behaviour. However, antecedents, such as lectures, safety rules, procedures, instructions, toolbox talks, and risk assessments, are ineffective in bringing about change on their own. Krause explains,

"Many well-intentioned safety programs fail because they rely too much on antecedents – things that come before behaviour…All too often these same antecedents have no powerful consequences backing them up." Krause [56; p. 37]

In the same way, training courses that concentrate on instruction (antecedents) where the emphasis is on what the teacher teaches and not on how the student learns, are unlikely to bring about behaviour change. As Krause states:

"both antecedents and consequences influence behaviour, but they do so differently:
- *consequences influence behaviour powerfully and directly*
- *antecedents influence behaviour indirectly and serve to predict consequences."*

The author maintains that both are important and thus have designed the crew resource management course in accordance with Antecedent-Behaviour-Consequence (ABC) principles. The course provides the opportunity for the students to practice the behaviour (B) that has been learnt in the lectures (A) and through the debrief session after an exercise receive feedback on their actions (C).

Antecedents

The aims of the crew resource management course are met by emphasising skills that will increase shipboard officers' abilities to act responsibly to health, safety, and environmental concerns. Table 1 below identifies the types of skills that are taught on the CRM course.

Table 1. Crew Resource Management Skills Taught at WMC

SOCIAL SKILLS	**COGNITIVE SKILLS**
Co-operation	**Situation Awareness**
Open communication	Situation assessment
Consideration for others	Risk assessment
Team working	
Leadership and Managerial Skills	**Decision Making**
Situational leadership	Problem diagnosis
Assertiveness	Option generation
Planning and coordinating	Option selection

Within the Warsash training course, the lecturer inputs are descriptions and explanations of the following:

- models of human error
- error chain analysis
- effective communication
- cultural awareness
- interpersonal influence
- situational leadership
- situation awareness and the rule of three
- critical thinking techniques for decision-making in a crisis

In accordance with the theories of learning presented above, the course begins with teacher led instruction. However, the students are not subjected to transmissions of information, rather syndicate groups, question and answer sessions, and case study analysis are an integral part of the lectures to ensure that the students are engaging with the material. The intention is to develop the students' independence in preparation for the simulator exercises that begin in the middle of the week and occupy all of the time in the last two days of the course. These teacher led activities are antecedent to student-centred activities described under the behaviours section below.

Behaviours

There have been a number of training programs produced that aim to improve the higher order cognitive skills of the students within specific context [57, 58, 59]. These techniques have been adapted at Warsash to try and improve the students' social skills such as communication and co-operation. Some of the techniques used are:

- having students justify their solutions to one another
- having students evaluate other students solutions
- allowing students to make and correct errors

Other studies have been directed at trying to generate training techniques to improve general problem solving skills that would be transferable into different contexts of application [60, 61, 62]. These techniques, listed below, have also been adapted at Warsash to improve the students' cognitive and metacognitive skills:

- considering multiple sides of an issue (lateral thinking)
- considering consequences
- selecting goals and planning strategies
- prioritizing factors involved in a situation
- generating and evaluating evidence
- using perceptual rather than logical thinking
- extensive practice of solving problems
- teaching the use of heuristic strategies
- use of graphical representations to show the structure of problems

In effect, the lecturing staff are making the most use of learning through social interaction, and are attempting to capitalise on the range of experiences and learning styles within the group. The teacher decreases the structure and control of the classes as students first enter their *zones of proximal development* and second, move through to develop new *abstract conceptualisations*, that they are eager to test out in the simulators. This latter phase of learning is further developed through the Consequences aspects of the course.

Consequences

"Debriefing is the key to the entire learning process, during which trainees' knowledge and attitudes are applied, tested, analysed and synthesised." [63]

A student-centred debriefing technique has been shown to be more effective because students learn better through self-discovery and self-analysis than by lecture. The student-centred debriefing technique draws upon students' professional expertise and motivation to perform well, and it helps the lecturer understand the students' performance.

Until students have the opportunity to reflect on that which they have experienced during a simulator exercise, it is doubtful that any real learning will take place. The 'debrief' integrates the simulation experience into the learning environment. Debriefing is the critical phase of learning, where the individual begins to understand events experienced. These accommodations of new information form the essence of meaning. Students learn to tie things together, to connect part to part to whole.

However, students may, or may not process their newly acquired information correctly. Through the debriefing process, the lecturer can ensure that new learning is processed in the correct manner. The debriefing process should provide feedback to the lecturer on the students' value of, and understanding of, the simulation. It also provides feedback to the students about the consequences of their behaviours. Lecturers need to ascertain whether the students' experiences matched those of the real world and whether they believed the experiences were useful.

Overall, the team behind the CRM course being run at WMC have designed the course to ensure that non-technical skills are not only taught but are also learnt. This has entailed designing the course to contain the types of knowledge that has significance for effective performance, structuring the sessions such the students are engaged, and gradually introducing simulation exercises so that the level of student autonomy has developed sufficiently to make the *extended abstract* learning possible. However, it has to be borne in mind that crew resource management training, even if well designed, is not a panacea for human error prevention.

5. LIMITATIONS OF CRM TRAINING

There is now a general acceptance of the core concepts for the non-technical or resource management skills required for competence in shipboard operations. There is also an acceptance that the behaviours associated with these skills are context specific. Helmreich *et al.* [64] suggest that the optimal implementation of resource management skills is dependent upon the cultural context in which they are applied.

The maritime training community often finds that the application of CRM style training is limited to a retro-active 'dose' of post incident remedial training. A collision or a grounding is likely to result in bridge teams being prescribed a course of 'treatment' in passage planning; an engine room fire or catastrophic failure is likely to result in engineering officers being prescribed a course of treatment in engine room management.

Quite rightly, the management of shipping companies feel that these potentially life-threatening incidents need to be addressed. The human errors arising from poor judgement, poor situation awareness and procedural violations are unpacked to see what lessons can be learnt. Officers are sent on the courses in the hope that their erroneous behaviour can be un-learnt and replaced with more appropriate behaviour. In effect, training colleges are asked to 'fix' problem employees. The training colleges oblige with a week's course for the problem employees but it is unlikely that the course members will ever sail together as a team.

In our rush to fix the problem employee, we are all in danger of missing the point: different ships, different teams, different individuals, but the same sort of incidents keep occurring. Something more fundamental, more deep rooted than operator error is at fault. In the same way that having a documented safety management system does not make a company safe, having employees attend CRM courses does not make a ship safe. Most company managers fail to ask why this is the case. Training is often seen as an end in itself and little effort is made to follow up the training by seeing how effective it has been on board the vessel itself. Little or no research is done to analyse whether solutions other than training are more appropriate and the training community unwittingly colludes in this self-deception by supplying yet more customised courses.

At Warsash, the research team are attempting to address this thorny issue, if not in whole, at least in part. In an effort to foster behaviour change beyond the usual 'honeymoon phase' of the training intervention, a reflective practitioner [65] initiative has been developed and is being trialled. Before the start of the course proper, course attendees are encouraged to reflect on past experiences (*concrete experience* in the words of Kolb), to ascertain where their behaviour is effective and where it is ineffective. At the end of the course, the students are asked to think about what they have learned and how they might apply this new learning in the workplace, i.e. onboard ship. Three month's after they have attended the course, the students will be followed up to establish what they remember (*unistructural* learning), what they have applied (*relational* learning) and what they believe to be the enablers and constraints to applying what they have learned (*extended abstract* learning) on board ship. This latter aspect of the reflective practitioner exercise will also enable the research team to establish whether the culture in which the students are attempting to apply their newly learned non-technical skills, is receptive or hostile. In other words, this research will help us to understand the extent to which company culture influences accident likelihood and inhibits safe behaviour.

6. CONCLUSIONS

As in similar safety-critical industries, the analysis of maritime accidents over the years has revealed shortcomings in the ability of operators to manage both resources and crises. CRM training has been seen increasingly as a fundamental part of the human error management philosophy. Although CRM training has become well established in the maritime curricula, as with civil aviation, there remains a question mark about how effective such training actually might be in improving safety performance. Analysis of recent casualties also suggest that CRM training, although important, may not be a panacea for prevention of accidents and that organisational factors, as well as operator error, must also be taken into account.

Notwithstanding this conundrum, there is much that maritime colleges can do to improve the learning of their students. Whether the courses are simulator-based or not, theories of learning suggest to us that we must tailor our courses to meet the needs of the students. Students need to be given opportunities to be active discoverers rather than passive recipients of knowledge and thus courses dominated by one-way lecturer transmissions are unlikely to be effective. Students also need to be able to interact in a social environment, one in which the teacher gradually reduces control, and one in which students' brave efforts to develop understanding are encouraged. Introducing elements in the course requiring student independence too early can backfire leading students to become defensive and shut down their learning. Students also need to be encouraged and guided in the interpretation of experiences, whether in a classroom discussion or post a simulator exercise. Reflection on experience is a process that has a powerful effect on adults' learning. By encouraging our students to carry this process on beyond day five of the five-day course, we have the potential to get beyond the honeymoon period normally associated with training interventions and bring about lasting attitude, behaviour and cognitive change.

In summary, encouraging attitude, behaviour and cognitive change in ships' officers is not as simple as ABC. Indeed, it is a very complicated and challenging activity. However, by following the ABC principles identified above, teaching non-technical skills to ships' officers can be more effective and greatly rewarding.

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