ABSTRACT

Conventional schooling, as a means of training mariners, was introduced to many maritime nations by STCW convention. Before that, apprenticeship was the most common means of acquiring maritime competencies. Apprenticeship training fosters learning skills and knowledge in its social and functional context. It engages beginners in the field to work under the supervision of an expert and gradually acquire various elements of competencies.

In recent decades, especially after the introduction of the STCW Convention, the maritime domain gave up most of the opportunities of learning onboard ships, in favor of school-based vocational education. STCW asks for the amalgamation of formal schooling and on-the-job training. School-based instruction now dominates even in many parts of the on-the-job training programs. This leads to difficulties that frequently arise in acquiring and transitioning knowledge to workplace.

Most of today’s maritime education and training programs arrange for the students to start with theoretical knowledge, abstracted from their use in the workplace, in a training institute. Thereafter, students have to spend a period of time onboard ships, as on-the-job training, to put their theoretical knowledge into practice. As the minimum requirement for the time to be spent for practical training at sea is relatively short and training onboard ships is not normally supervised, students receive limited opportunities to engage and learn by participating in professional activities. The combination of school-based instruction and unstructured and unsupervised on-the-job training produces unsatisfactory results. Many mariners never get the chance or the proper learning environment to become authentically competent.

The reduction in the number of crew, fast turnaround of ships in ports, complying with tasks associated with an ever increasing number of relevant conventions and codes, and a resultant increase in workload of crewmembers leaves very little room for mariners to engage in and supervise the training of apprentices’ onboard ships. Finally, today’s shipboard navigation with the extensive use of automated and computerized systems, in some cases may not provide visible cues for the trainees to learn the job by pure observation. As a result of today’s conditions, conventional apprenticeship alone cannot fully provide mariners with their needed competencies.

This paper provides an overview of the current status of maritime education and training and discusses the possible flaws and shortcomings, which results in an inadequate educational system. Based on this, we confer the need for reform, improvement, and a new approach to education and training of mariners.

Keywords: Apprenticeship, Cognitive apprenticeship, Maritime education and training

1. INTRODUCTION

There has been a great concern about the human factor and mariners competencies onboard ships in the last few decades. The maritime domain has indicated its concern over this issue by the introduction of harmonized education and training system through STCW convention. Despite this extensive international system, which requires mariners to acquire and continuously upgrade their knowledge and skills throughout their working life, there continues to be a large number of maritime accidents ultimately attributed to human failures. Current reports indicate that the number of marine accidents and incidents due to the human factor and their lack of competencies are growing. The statistics of leading insurance companies show that there has been an increasing trend in navigational accidents in recent years. For example, the DNV updated figure for 2007 shows that the
number of serious groundings, collisions, or contact accidents, has doubled in the past five years (DNV, 2008). This is contrary to the result expected from decades of efforts that IMO and the entire maritime nations endure, to improve the competency of mariners. The question: why is it that even though more effort is put into current maritime education and training systems, less success is achieved?

As required by STCW, to be a certified mariner, each candidate should be able to demonstrate the competencies prescribed in the convention. These competencies are to be achieved through a combination of education and training plus practical experience (IMO, 1996). Maritime education and training generally consists of education of knowledge of defined theoretical subjects and training of skills in a number of practical short duration courses, in the training institutes plus a mandatory period of seagoing experience onboard ships. The education and training models are based on interaction and turns of these segments. In the following sections we discuss the functions of these different segments. By analyzing the current condition of maritime education and training, this paper tries to demonstrate and discuss the possible limitations and shortcomings of the system and the need for a new epistemology for maritime education and training. Furthermore, the paper proposes an alternative approach that may improve the system.

2. Schooling and the Acquisition of Competencies

In the following section, we briefly discuss some of the key shortcomings in current pedagogical practices. This paper then presents some of the structural features of traditional apprenticeships and discusses, in general, the requirements of adapting these characteristics to the teaching and learning of cognitive skills at schools.

2.1. Education in Training Institutes

The practices in maritime training institutes are mainly based on conventional and formal schooling. Formal education is originally designed to provide the knowledge and understanding required by students to underlay their future tasks on the job. Although the main purpose of the formal education is to give the students the theoretical background and the knowledge that they require on-board ships but practically the system is not successful in achieving this goal, in. Many mariners generally are not able to transfer that theoretical knowledge to their job. In the following we discuss some of the systemic reasons for ineffectiveness of schooling:

a) Our education in schools is based on the assumption that the theory can be separated from practice. It presupposes that only by knowing the theory of a task we would be able to do it; that we can teach a task by breaking it into subtasks and teach each one separately, out of context. We assume that students, when on the job, are able to combine these subtasks together and perform the task competently. We treat knowledge as an integral, self-sufficient substance, independent of the situation in which it is learned and used (Brown, Collins, and Duguid. 1989). Our schools’ primary concern is to teach the knowledge which is abstracted from reality and taken out of context. This pedagogical perspective does not consider the effect of the context and activity on the learning. In recent decades, many researchers in the field of learning have shown that this is not the case. What is learned is integrated to how it is learned and used, whereas knowledge is situated through experience (e.g. Lave, 1993; Barab and Duffy, 2000). The activity in which knowledge is developed is not separated from the learning and cognition; rather it is part of what is learned. It is in situations that we share and learn knowledge through participation and activities. By ignoring the situated nature of cognition, education cannot reach its own goal of providing usable and applicable knowledge.

b) Economy of education requires the schools to arrange students into groups. In addition, they have to have a single set of curriculum to teach. In order to teach a specific curriculum in a specified period of time, schools have to assume an average level of ability for students to learn the amount of knowledge required by the curriculum. It asks for all the students to learn the same curriculum in a fixed period of time. It means that those students who are above or below that assumed average level, have to suffer as either they are wasting their time or do not receive enough time to learn the subject matter in curriculum. This is one of the fundamental faults of the current schooling system. There is also no appreciation of students’ prior knowledge of the subject and there is no systematic way assigned to measure that.

c) Learning at schools has a different format compared to learning at work onboard ships. Classroom learning is mainly based on lectures, reading and discussions about a task. Learning at work onboard a ship involves observing, coaching, mentoring and practicing the task. A mariner teaching at a school has a different profession from a mariner teaching at work onboard a ship. Professional mariners are experts in their field and would be
able to teach the way that they practiced and experienced at work. Bringing mariners to school to teach requires a change of profession and attitude toward learning. They have to spend many years at school to be professional teachers of maritime knowledge. On the one hand, you have an up to date profession in the field and on the other hand you have a professional who may not be up to date in his field. It contradicts itself, because as teachers they have to devote their full time for teaching to be a professional teacher, consequently during this period of time their perception of what is required at work will fade and deteriorate especially as the competencies required from mariners are changing rapidly.

d) Although students are taught in groups in classrooms, dominant methods of school learning and performance is individualistic. The main part of in and out of class activities, such as working on exercises, is designed to be done by students individually. The assessment system is also evaluating students based on what they can do, independently. In contrast most of the mariners’ activities onboard ships are shared with others. The successful and safe operation of a ship is dependent on shared activity of all crewmembers. The fact that many accidents are caused by mariners acting by themselves, independent of other crewmembers, is a well-known reality and the need for the mariners to attend “bridge resource management” courses is the witness. Yet, the training institutes do not apply this principle to the rest of education and training.

e) The other difference between what we teach the mariners at training institutes and what they actually do on ships is the use of tools. Teachers and examiners ask students to do the tasks without using available tools, which can be as simple as a calculator. This is what Resnick (1987) calls “pure mentation versus tool manipulation”. This is also true for the assessment and certification system. It is evident to schools that when their students are employed onboard ships, they are going to use all available tools and may never need to process raw data and calculate the required information. They obtain it through the use of tools and from instruments and electronic aids. It would be wise for schools to teach the students how they may use the available information and already processed data rather than teaching them how to process the data.

f) Although evaluating students has to be based on their ability to perform the competencies, schools place emphasis on knowledge assessment mainly by means of written examinations. Students’ perceptions about assessments significantly influence their approaches to learning and studying (Boud, 1995; Struyven, Dochy, and Janssens, 2005). This shifts their objective from acquiring competencies to memorizing what is required to pass examinations (Emad and Roth, 2008). This affects the whole education and training system as the students aim is to pass the exams, knowing that all they have to do is get ready for the type of knowledge which is required in formal examinations not the ability to perform a task competently. What these tests can measure is the ability of students in taking test and in coping with the anxiety of examinations (Mechanic, 1962).

The above-mentioned facts are mainly concerned with the teaching of theoretical knowledge in schools. There are parts of teaching in schools, which generally includes skill training. These consist of short duration, safety and simulation courses. This part of schooling acts more successfully as it include the use of tools plus shared and practical activities that are similar and more related to what mariners do at sea. Yet the fact that these activities are performed at school and not the real work environment, also isolation of each task from the whole related activity (as it is evident in part task trainings) reduce the effectiveness of their outcomes (Emad and Oxford, 2008).

Based on the above-mentioned facts the current conventional schooling has many shortcomings and is not a very effective method for maritime vocational training. In the next section we discuss apprenticeship and practical training onboard ships.

2.2. Traditional Apprenticeship

The traditional methods, using ships, to provide practical experience have long been recognized as the effective training method by many maritime training institutes (Ciccek et all, 2002). Recent theories of learning, instruction, and cognition also support the fact that the best learning environment is the workplace where the apprentices engage in authentic, interactive, and meaningful learning where they create their mental models (e.g. Lave, and Wenger, 1991; Brown, Collins, and Duguid, 1989). Among the mariners, on-the-job training is generally held to be the best part of their training in developing the competency that they need, to act successfully in their job. In contradiction to formal schooling which reduce the importance of learning to acquiring isolated units of
abstracted knowledge, apprenticeship promote learning skills and knowledge in their social and functional context (Collins, Brown, and Newman, 1989).

The customary practice in traditional apprenticeship is for a beginner to work on a ship and gradually acquire various elements of skills. In that type of training, apprentices spend hours and days watching officers and crew members at work. As an apprentice, they start with practicing basic skills—for example lookout and steering a course. From the beginning, trainees observe full processes of the job—e.g. navigation. After achieving the acceptable level of competence in these basic skills, they attempt to participate in the entire process of a simple part of the job—e.g. choosing proper landmarks and taking bearings for obtaining the position of the ship. When the apprentice became competent in that task then s/he is ready to do more complex tasks and so attempts to do the entire process of that part of the job of an officer—e.g. plotting the position on the chart, calculating and drawing courses and, later, the whole passage planning. These tasks are not practiced as an exercise but as part of the job of a navigating officer. Although the officer of the watch might check the apprentice’s work occasionally, it is the apprentice position on the chart that is used for navigation. When competent, the apprentice begins to work on another, more complex task and thus proceeds through a "curriculum" that always exercises tasks and skills in the context in which they will be used. Although there is very little direct teaching—only occasional instructions or pointing out errors by the officer or masters—there is much learning through this graded, contextually embedded practice (Resnick, 1989). There is also considerable self-correction, because apprentices, through observation, have established criteria against which they can judge their own work (Lave, 1977). In this method, assessment is a continuous process and apprentice performance is always evaluated and, if needed, corrected at the time of performing the tasks.

The apprentices learn onboard ships where people, in a routine way, do whatever a competent mariner should do. They find themselves in an environment complete with characteristics, situations, activities, and problems they will face as long as they remain mariners. Thus, they feel and see the kind of work they have to learn with all its complexities from the first day, instead of being introduced to these complexities one step at the time. Some apprentices give up their desire for this job quickly when they realize that what they have gotten into does not suit them. Those who remain have a very good idea, from the start, of what type of career they have chosen. They live in and learn about the culture, physical environment, technical difficulties, and the dangers associated with this job. They can learn by participation in these activities based on availability at that time and their willingness. They learn at the speed that they choose and are suitable for them. An apprentice designs his/her personalized scheduled curriculum (Becker, 1972).

2.3. Training Onboard Ship as Part of Formal Education
Traditional apprenticeships, although available to, is not dominant practice for training mariners. Today’s training onboard ships is limited in time and is only part of the whole education and training system. While there is a great potential in the training on-the-job, in practice, it is not taken seriously by most of the ships’ staff and students and, as a result, the learning outcomes are unpredictable (Emad, 2007). One of the main problems is the lack of supervision on and cooperation with the students’ learning on-board ships on the part of ships’ personnel, shipping companies, and training institutes (Lewarn, 2002).

The dominant practice is that the education and training is separated from the work and the responsibility of training of cadets is not part of the duties of shipping companies and their ship’s personnel. Besides, as ships are out of jurisdiction of training institutes, they have limited control over the training quality there. Furthermore, the time required to be spend for training onboard ships is relatively short, especially after the introduction of STCW95. The students have very limited time and opportunities to acquire competencies that they need to learn onboard ships. It is evident that they receive very limited opportunities to do the real work activities. They need extensive time to relate theory learned at school with related task in practice and yet some of the tasks may not even practice during that period of time. As a result, in this limited time, the trainees cannot be exposed to the full range of conditions that a ship’s officer has to experience to be fully competent.

Beside the mentioned shortcomings, today’s high technology and rapidly changing work environment onboard ships also seems, to some extent, preclude many traditional and authentic opportunities of apprenticeship activities. Due to the increasing use of technology and automation, neither the equipment's functions nor the mental activities of officers while working with the equipment on the bridge is visible (Asyali, 2003). This leaves limited visible trace for the trainees to learn the job through observation of officers at work and it is unlikely to
support the desirable and necessary conceptual development that occurs in the traditional apprenticeship. In addition there is an increasing workload due to reduction in the number of crew and fast turnaround of ships in port, which caused longer and more intensive periods of work and increased responsibilities for each officer onboard ships. This considerably reduces the amount of time that officers may spend for monitoring and supervision of training of the apprentices (Kahveci, 1999). Finally, the combination of school-type instruction, unstructured and unsupervised on-the-job training, and the current work environment onboard ships, produces unsatisfactory results. Many trainees never get the chance and appropriate environment to become a competent officer even when they are certificated. As a result the current maritime training and education system cannot provide mariners with today’s entire required competencies and there is a need for an alternative approach to the education and training system. This should complement the on-the-job training onboard ships and provide the authentic learning environment in schools for the students to practice and acquire the competencies in similar culture, social interactions and environment as ships.

Our training system has to benefit from and include both on-the-job apprenticeship and improved and modified school-based education. Apprenticeship training has to be organized and considered as the most effective and valuable part of training students. There is a need for ships’ personnel to take the responsibility of training and supervision of students onboard their ship. Schools have to effectively monitor the training process of their students while they are on the ship. School-based education is necessary to provide students with those competencies, which cannot be acquired through traditional apprenticeship. To achieve this, there is a need for schools to base their education on the related elements of traditional apprenticeship, which provides authentic learning. The schools should be able to create authentic learning environments for students to engage with and learn related tasks in environment similar to work conditions and cultures. One of the possibilities is to use the concept of cognitive apprenticeship as introduced by Collins and his associates (1989). Cognitive apprenticeship is an instructional model, which is based on current understandings of how individuals learn (Bransford, Brown, and Cocking, 2000). This concept tries to implement the principle of learning of the traditional apprenticeship to learning cognitive skills in the school environment.

3. Cognitive Apprenticeship

As discussed earlier, the apprenticeship system has proved to be an effective form of education. By working alongside a master, officers, and other colleagues, apprentices learn many skills and competencies. The apprenticeship system also requires students, to serve as resources for each other in exploring the new domain and aiding and challenging one another. Inspired by a traditional apprenticeship, the notion of a cognitive apprenticeship has been presented by Allan Collins and his colleagues (1989) as a way of replicating the critical elements of an actual apprenticeship for the learner in the school environment. Thus, cognitive apprenticeship is the use of a principle of apprenticeship in the process of learning (Brown, Collins, and Duguid, 1989). In this method, the teacher is then able to employ the methods of the traditional apprenticeship, which includes modeling, mentoring, coaching, and fading to effectively guide student learning (Collins, Brown, and Holm, 1991). The cognitive apprenticeship aims to create a meaningful social context in which learners are given many opportunities to observe and learn expert practices. Like traditional apprenticeships, in which the apprentice learns by working with competent mariners, cognitive apprenticeship allows the teacher to model mariners’ behaviors in the classroom. The use of dedicated training environments, instead of workplaces, is an advantage as it allows a higher ratio between expert and novices. This permits a larger group of students, compared to the traditional apprenticeship, to engage in learning the same task with the expert.

One of the important elements of the traditional apprenticeship is the availability of the process of performing a task for the apprentices to observe. There is a transparent relationship between skill, its use and the result of its application. It makes it easy for student to learn by observation and for experts to monitor its application by students and to see and diagnose if there is any error in understanding or application of skills. As mentioned earlier, there are tasks that are more internalized and do not leave visible clues. For example, use of technology or performing higher order cognitive skills such as calculation. As applications of this kind of knowledge are through thinking and cognition, students cannot observe the application of the knowledge by the teacher at the time of teaching and problem solving. Likewise teacher have no access to students cognitive processes when learning and applying that knowledge. Cognitive apprenticeship tries to externalize these processes by bringing them into the open and letting the unobservable aspect of cognition and theory appear to students at the time of its use. One of the methods that may help reaching this objective is using the technique which Collins and Brown (1988) called abstracted replay. It asks for alternation of effort between teacher and students in a shared problem-
solving context. In this process teacher and students explicitly explain what they are doing and the processes of performing the task. In this way the hidden cognitive activity of the teacher while performing the task would be available to students. Through discussion, alternation of teacher and learner role and group problem solving both teacher and students will have access (through verbal and written description) to each other’s understanding and use of knowledge. By observing and listening to the teacher and taking part in the problem solving, the apprentices can identify relevant behaviors and develop a conceptual model of the processes involved in carrying out that task. As it involves learning by externalizing thought processes in diagnosing problems, it allows learning complex tasks and problems solving which uses higher order cognition. The apprentices then attempt to replicate those behaviors while the teacher observes and provides mentoring and coaching. Coaching provides assistance to students to do beyond what they could accomplish by themselves (Vygotsky, 1978). The teacher will provide assistant and corrective feedback with the intent to bring the apprentice’s performance closer to that of the competent mariners. The coaching gradually fades as the apprentice becomes more skilled through the repetition of this process, and ability to perform the task at a competent level (Johnson, 2002).

Cognitive apprenticeship expanded the traditional apprenticeship teaching method of modeling, coaching, and fading further to articulation, reflection, and exploration of ideas. In the articulation stage, the teacher encourages students to verbalize their knowledge and thinking about the task and its performance. The role of the teacher here is to encourage students to explicate their knowledge, reasoning, and problem solving strategies and so test their understanding of knowledge. Then, through the reflection process, students compare their performance with other students and the teacher. Here, students compare their problem solving processes with the teacher’s work and with that of other students. Such comparisons aid students in diagnosing their difficulties and gradually adjusting their performance until they achieve competence. And finally, in the exploration stage, the teacher invites students to pose problems related to the task and solve it on their own. It helps students to gain confidence in their ability to set achievable goals, shape and test hypotheses, and make independent discoveries (Collins, Brown and Newman, 1989; Collins, Brown and Holm, 1991).

3.1. Cognitive Apprenticeship and Situated Learning
The cognitive apprenticeship model is based on the idea of learning in context. Cognitive scientists believe that the context in which learning takes place is critical (e.g., Godden, and Baddeley, 1975) and cognitive processes are situated in physical and social contexts (Greeno, Collins, and Resnick, 1996). Situated cognition considers thinking as embedded in context and draws upon social, cultural, and material resources. Thus, cognitive processes do not reside solely in a person's mind (Cole and Engestrom, 1993). That is why learning is often described as "enculturation," (Rogoff, 1990) or adopting the norms, behaviors, skills, and attitudes of a particular community (Lave and Wenger, 1991). Based on findings such as these, Brown, Collins, and Duguid, (1989) argue that cognitive apprenticeships are less effective when skills and concepts are taught independent of their real-world context and situation. In cognitive apprenticeships, schools have to maintain the marine culture in the classroom. An instructor has to be and act as a professional mariner and not a traditional instructor. Problems have to be designed from the context of ships with its natural complexity and extend, and not broken down to a simplified version. Examples from real life can be used. For instance, well documented accidents or the problems experienced by the instructor or students while they were onboard ships. These problems have to be solved the way mariners normally work it out. Related resources available to mariners have to be available to students as well.

Today, in our training institutes, we have many opportunities to create environments, which are similar to the authentic maritime domain. One of the best opportunities is provided by the presence of simulators. If used effectively, they can help instructors in providing the context and environment similar to the ship. It can be used for learning many tasks and activities. The flexibility of simulators for providing different context, by changing the settings and virtual environments, would be of greatest benefit to the students to exercise tasks in different situations in much shorter period that they could do onboard a real ship. The use of carefully designed simulated environments, which considers the technological and social complexity of modern navigation, as part of the training programs would be a great asset. But care must be taken as in many cases the use of simulation technology with conventional education and schooling mindset produces ineffective training outcomes (Emad and Oxford, 2008). For example, for training in the use of an electronic navigational aid, schools normally use the stand-alone part task simulators. They have to realize that the introduction of a new technology is not simply adding new equipment in the bridge to help mariners. It creates new context and domain on the bridge so education should not only focus on training people for that isolated equipment separated from the bridge context.
but for the whole new domain. These technologies change the way mariners do their job and give them new ways of looking at and dealing with their tasks.

The authors believe that the use of the cognitive apprenticeship method in maritime education and training gives students the opportunity to observe, engage in, and invent or discover expert strategies in its related context. Such an approach will enable students to see how these strategies fit together with their factual and conceptual knowledge and allow them to make use of a variety of resources in the social and physical environment of ships.

4. CONCLUSION
As discussed, at present the majority of our training institutes do not have any great effect on the development of competencies of mariners. Many of our educators so deeply believe in the idea that learning can only happen in traditional schooling that it prevents them from questioning the epistemology that underlies its existence. It prevents them from looking into, appreciating and validating other methods of learning. Although, as it discussed, today’s complex and ever changing work environments onboard ships do not allow traditional apprenticeships alone to fully utilize all the aspects of maritime training, using the underlying elements of this successful method may considerably improve the maritime education and training system. The cognitive apprenticeship tries to incorporate key elements of apprenticeship method into the teaching and learning in schools. This method aims to let the students learn the processes that the competent mariners use to manage and do complex tasks in their jobs. Combination of supervised traditional apprenticeship programs onboard ships and cognitive apprenticeship programs in training institutes is one of the ways of providing our mariners with an authentic learning environment, which allows them to acquire their competencies. This epistemology might hold the key to a dramatic improvement in learning and a completely new perspective on maritime education and training.

5. REFERENCES


